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**DARLINGTON NGS
PREOPERATIONAL AQUATIC STUDY - 1985**

Report No 89-166-K

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ABSTRACT

In the second preoperational year, alewife numerically dominated the gill net catch (92.25%), followed by round whitefish (2.26%), lake trout (1.22%), white sucker (0.83%) and brown trout (0.57%). Alewife catches at the offshore end of the diffuser were significantly lower than at all other sites. Increased catches of round whitefish from 1984 to 1985 were not significant, but the catch at the inshore end of the diffuser was significantly higher than that at the east reference area. Lake trout catches in bottom nets were about double surface catches, while the reverse was observed for brown trout. Larval round whitefish were sampled in 219 paired net tows in April - May, yielding 8 larvae (5 in bottom tows, 1 at mid-depth, 2 at the surface). Blasting for excavation of the CCW intake resulted in a local kill of alewife (<1000 fish/blast). Alewife mortality was observed to a distance of 200 m (total kill within 50-75 m). Adverse effects on yellow perch and rock bass in cage tests were restricted to the immediate blast area (25 m). Rock bass eggs exposed to a blast (25 to 1000 m) showed no increased mortality. Settling tubes east and west of the intake excavation indicated peak sedimentation in the immediate vicinity. Secondary peaks occurred about 200 to 250 m on either side of the intake. At the offshore dump site, sediment deposition was highest within 200 m of the dump site. Secondary peaks occurred at 800 m west, 600 m east and 1400 m east.

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34-127-492	837.321 DAR	August 18, 1989	89-166-K



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EXECUTIVE SUMMARY

DARLINGTON NGS PREOPERATIONAL AQUATIC STUDY - 1985

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This report describes results for the second year of preoperational aquatic studies at Darlington NGS. Objectives for this year were to monitor the relative abundance and species composition of juvenile and adult fish with gill nets, monitor the reproduction of fall spawning fish (especially round whitefish) through spring sampling with larval tow nets and a benthic sled, conduct acoustic surveys of fish in the vicinity of the discharge mixing zone and the PPB intake, assess effects of underwater blasting (for the intake excavation) on fish, and measure sedimentation resulting from intake excavation and dumping of excavated material.

Juvenile and adult fish were sampled in 64 gill net sets (May to December), yielding a total catch of 8,659 fish. Alewife numerically dominated the catch (92.3%), followed by round whitefish (2.26%), lake trout (1.22%), white sucker (0.83%) and brown trout (0.57%). The rainbow smelt catch (46 fish = 0.53%) was much lower than in 1984 (853 smelt = 7.6%).

Few alewife were taken in early May or after October 16. Peak catches occurred in late July and mid-October. Round whitefish catches were low until mid-October, increased through November, then rose sharply during the December spawning period. Catches of salmonids (lake trout, brown trout, rainbow trout and Pacific salmon) were highest in October and November.

The average alewife catch at the offshore end of the diffuser (location 'D', 45.7/net) was significantly lower than at all other sites (from 135 to 164/net). Catches in surface nets (133/net) and bottom nets (119/net) were not significantly different. Round whitefish were collected almost exclusively in bottom nets. October to December data (when abundance was highest) indicated that the increase in fall round whitefish catch from 1984 (5.5/net) to 1985 (11.1/net) was not significant, but the catch at the inshore end of the diffuser (site 'A', 16.7/net) was significantly larger than that at the east reference

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area (site 'H', 3.3/net). Intermediate catches were obtained at the west reference area and the offshore end of the diffuser. There were no significant locational (site) differences in lake trout or brown trout catches. However, lake trout catches in bottom nets were approximately double the surface catches, a significant difference. Brown trout surface catches were about double the bottom catches, also a statistically significant difference.

A total of 219 paired net tows were made from April 17 to May 23 to collect round whitefish larvae. Approximately equal effort was made to sample the intake and diffuser areas at depth contours from 5 to 15 m, with tows being made at the surface, mid-depth and bottom. Eight round whitefish larvae were collected between April 17 and April 26. Five were in bottom tows, at depths of 5, 7 (2 larvae), 10 and 15 meters. One was collected in a mid-depth tow (5 m contour) and two were in surface tows (at 10 and 12 m depth contours). These results and past catches in the Pickering area (OHRD Report 87-181-K) suggest that round whitefish larvae are vulnerable to our sampling gear for only a brief period (April 15 - 30 in most years). Hence, our sampling effort should be concentrated in this period. Laboratory studies (OHRD Report 88-334-K) have suggested that night sampling may be more effective than the daylight sampling done in 1985. All larval fish sampling at Darlington has been conducted at night since 1987.

Only a single acoustic fish census was completed in 1985. As this survey was repeated in May, July and November of 1986, data from both years will be presented in a future report.

Blasting required for excavation of the Darlington CCW intake resulted in a limited local kill of alewife. Mortality was observed to a distance of about 200 meters, with a total kill occurring within 50 to 75 m of the blasts. The estimated average kill of alewife for the 6 blasts monitored was less than 1000 fish per blast. Lift net and diver observations indicated that almost all fish killed rose to the surface shortly after the blasts. Other species were much less susceptible to blasting. Cage tests indicated that substantial adverse effects on yellow perch and rock bass were restricted to the immediate blast area (approximately 25 m). Rock bass eggs showed no adverse effects when exposed to a blast at distances from 25 m to 1000 m. A single lake trout, stunned by a blast (only 10 m distant) appeared to recover and swam off before it could be captured for examination.

Sediment deposition data were collected from sediment tubes placed east and west of the intake excavation, at distances from 50 to 500 m. Reasonably complete data were collected during the period of excavation (June - August) and the initial period of sediment redeposition (August - September). Peak sediment deposition occurred in the immediate vicinity of the excavation (50 to 100 m), and secondary peaks in deposition were observed about 200 to 250 m on either side of the excavation. Sediments originating from the excavation were low in organic content and rather coarse-grained. A general increase in both total sediment accumulation and organic content from August to September suggests that higher current speeds increased movement of 'natural' sediments as well as redistributing the sediments from the intake excavation. By November, fall storms had obliterated the deposition patterns created during the intake excavation.

Deposition of excavated materials at the offshore dump site was monitored by sediment tubes set (at 200 m intervals) at distances up to 1400 m east and 1600 m west of the dump site. Total deposition over the June to August period was highest at the sites 200 m east and 200 m west of the dump site, with secondary deposition peaks occurring at 800 m west, 600 m east, and 1400 m east. As with the intake samples, the lowest organic contents occurred at the sites of greatest deposition. A broad range of particle sizes was observed in the large samples obtained near the dump site, indicative of nearby discharge. In contrast, sediments at the far-field areas of peak deposition were coarse-grained and unusually well sorted (most retained on 250 micron seive.). It is suggested that these samples resulted from discharge of material within the dump site during periods of substantial longshore currents. In previous simulation studies (OH D&D Report 84306), peak deposition was predicted to occur about 1000 m downstream from the dump site with average lake currents.

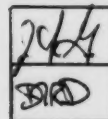


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To Dr. W.R. Effer
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DARLINGTON NGS PREOPERATIONAL AQUATIC STUDY - 1985

1.0 INTRODUCTION

Darlington Nuclear Generating Station has been under construction since 1977. When completed, the station will consist of four 850 MW capacity CANDU - powered units. Unit 2 is scheduled to become operational in September of 1989. Unit 1 is scheduled to start operation in September, 1990. Condenser cooling water will be drawn from a depth of approximately 10 m and discharged offshore at a maximum flow rate of 152 m³/s. Darlington NGS will incorporate two design features which are unique among Ontario Hydro generating stations: a precast porous bottom (PPB) intake and a submerged offshore diffuser discharge. The PPB intake was developed to reduce impingement of adult and juvenile fish. The diffuser was designed to rapidly mix cooling water to 2°C above ambient in order to protect coldwater fish spawning, without entraining near shore water.

The Environmental Studies and Assessments Department of Design and Development Division - Generation requested the undertaking of an initial aquatic study during 1984 (Ontario Hydro Research Division Report 87-82-K). The present study reports results for the second preoperational year and forms part of an overall environmental monitoring program (Ontario Hydro Design & Development Division Report No 84252) consisting of three years of preoperational studies (1984-1986), six years of commissioning studies (1987-1992) and three years of postoperational studies (1993-1995). The development of specific aquatic monitoring tasks was based upon three principal objectives:

1. To detect and quantify major, long-term changes in aquatic biota in the vicinity of Darlington NGS which have resulted from construction and operation of the station.
2. To assist in the assessment of local and temporary changes in aquatic biota resulting from the marine construction of Darlington NGS facilities.
3. To assist in the measurement of effects from the cooling water system with particular emphasis on the environmental protection features incorporated into the design of Darlington NGS.

Table 1 provides a summary of the main components of the overall aquatic monitoring program from 1984 to 1995. A schedule of activities for each study year is shown in Table 2. The program has been designed to include consideration of several hypotheses of the effects resulting from operation of Darlington. These hypotheses were developed at the Darlington Aquatic Studies Workshop (Greig et al, 1984) and are stated as follows:

1. Displacement of benthic invertebrates and demersal fish larvae into offshore surface waters may result from diffuser entrainment if a significant portion of benthic organisms are suspended by currents around the diffuser.
2. Mortality of larval fish entrained into the cooling water system may result in long-term reductions in fish populations if a significant portion of the larvae are entrained.
3. Discharges of warm water from the diffuser may lead to reductions in round whitefish, lake whitefish and lake trout populations by effecting changes in survival of eggs and larvae if egg mortality rates increase significantly or advanced hatch results in asynchrony with the food supply for a significant portion of the larvae.
4. The presence of an offshore diffuser may lead to reductions in walleye, trout and salmon populations due to increased angler harvest if a significant portion of local game fish stocks remain in the diffuser area for extended periods.

1.1 Objectives of the 1985 Aquatic Study:

In addition to continuation of the long term gill net monitoring program begun in 1984, this year included efforts to evaluate the effects from construction of the Precast Porous Bottom (PPB) cooling water intake. These studies involved assessment of underwater blasting effects on fish and measurement of sedimentation resulting from intake excavation and dumping of excavated material. Additional long term studies were also started in 1985. These included acoustic surveys of fish in the vicinity of the discharge mixing zone and the PPB intake, plus spring sampling with larval tow nets and a benthic sled for larval whitefish.

2.0 STUDY AREA

Darlington NGS is located on the north shore of Lake Ontario about 64 km east of Toronto and 5 km west of Port Darlington (Figure 1). Pickering NGS is 32 km to the west of Darlington. The nearshore area off Darlington NGS is characterized by an exposed shoreline and a lake bottom that slopes approximately 8 m/km. A small embayment, McLaughlin Bay, is situated about 6 km west of Darlington NGS.

The condenser cooling water intake for Darlington is approximately 900 m offshore, at the 10 m depth contour (Figure 1). An underground discharge tunnel

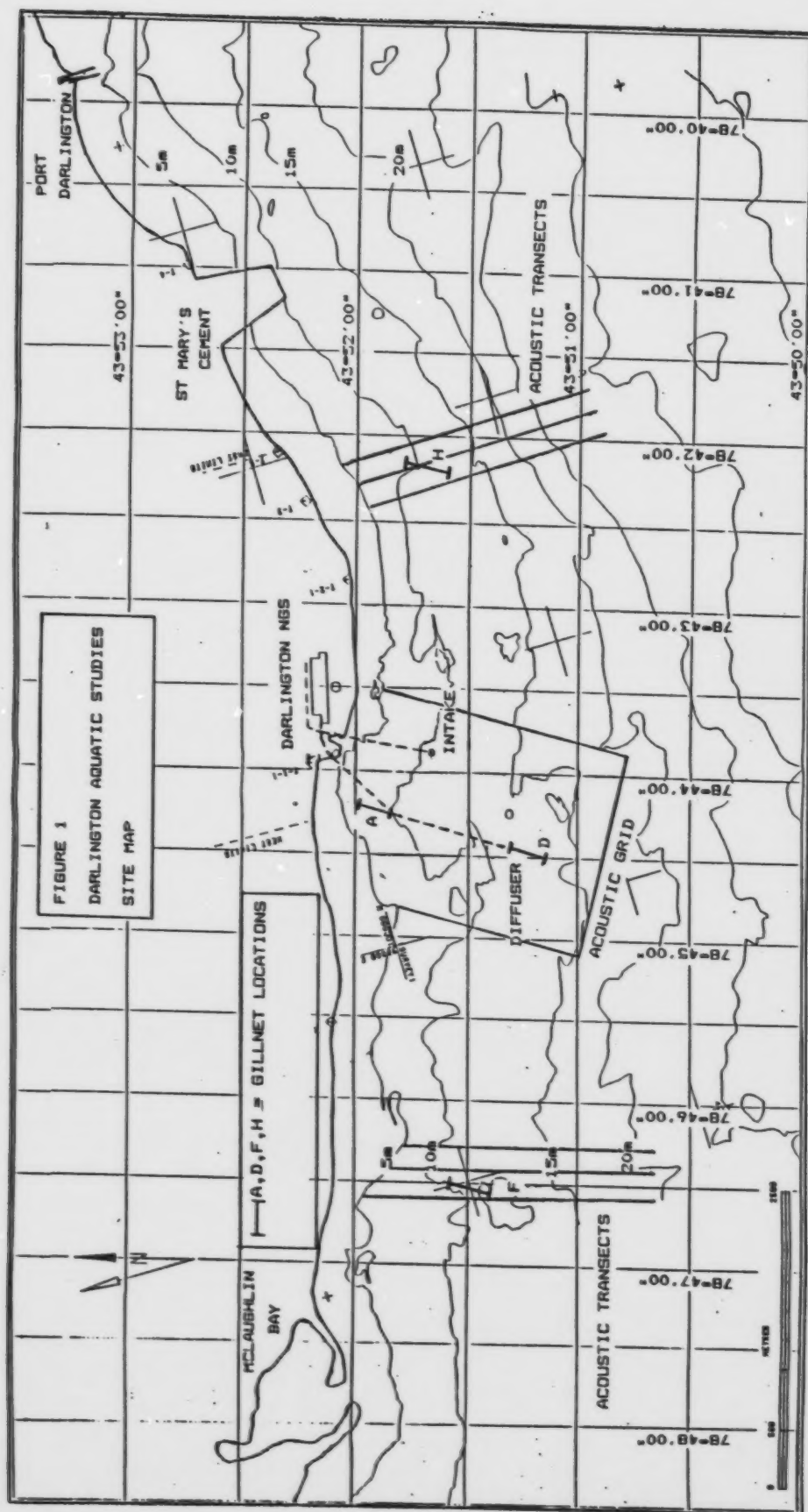


TABLE 1
SUMMARY OF PROPOSED MULTIYEAR AQUATIC WORK

OBJECTIVE	PARAMETER	SPECIFIC PURPOSE	SAMPLING METHOD	SAMPLING FREQUENCY		SAMPLING LOCATIONS
				WITHIN YEAR	BETWEEN YEAR	
1. To detect and quantify major changes in aquatic biota resulting from the operation of Darlington NGS.	Substrate monitoring	To measure the effects of bedload shift on fish spawning habitats.	Diver observation, photography, red measurements.	Approximately quarterly or clustered around major storm events.	Once in preop phase (1984/85), once in postop phase.	Twelve selected areas 10 m in diameter. Between 5 m and 12 m depth contours in and out of mixing zone.
	Predation by pelagic fish. (High variability may occur)	To characterize predation by pelagic fish on demersal fish larvae and benthic invertebrates and detect diffuser entrainment effects.	Analysis of stomach contents of pelagic fish from mixing zone. Fish collected by small purse seine or lift-net.	Once in each of May, July and September. 50 fish (smelt or alewife) to be collected each month. (Samples are for fish with food in stomachs).	Annual from 1985-1994.	Mixing zone vicinity and a location outside of the influence of the thermal outfall.
	Density of fish eggs and larvae. (Between year quantitative comparisons may not be possible.)	To estimate densities of fish eggs and larvae relative to entrainment, with a view towards assessment of reproductive success of cold-water species in mixing zone.	(i) Benthic sled conical plankton net tows, parallel to contours. (ii) Suction Pump (for eggs)	(i) Twice weekly in April and May (ii) Once in December	(i) Annual from 1985-1994 (ii) As above	(i) Along 5 transects centred on the mixing zone and 5 transects adjacent to intake. Plankton tows made at surface, mid-depth and near bottom. Sampling at approximately 5, 7, 10, 12, and 15 m contours. (ii) Selected areas.
	Adult and juvenile fish abundance.	To detect major changes in relative abundance of fish mixing zone, with emphasis on spawning activity.	(i) Gill Nets (ii) Acoustic Census (including some vertical gill net sets).	(i) Once in December and twice in May, July, October and November. (ii) Once in May, July and November (day and night).	(i) Annual in preop, commissioning and postop phases. (ii) Twice in preop phase (1985 and 1986), and once during 2 unit and 4 unit operation	(i) Along 3 transects: diffuser line, Port Darlington and McLaughlin Bay. Surface and bottom sets. (ii) Within 11-transect grids situated on diffuser line/ intake area and off Port Darlington. Transects perpendicular to shore (5-15 m depth contours).
2. To assess local and temporary changes in aquatic biota resulting from marine construction of Darlington NGS structures.	Sedimentation	To monitor the extent and duration of sedimentation resulting from intake excavation.	Sediment tubes on lake bottom, diver observation, photography, red measurements.	Collection of tubes monthly from April to November.	During 1985	Within 2 grids (1 km ² each) centred on excavation and dumping areas, at approximately 50 m intervals.
	Blasting mortality	To assess the mortality of fish due to underwater blasting	In situ test cages for eggs, larvae and adult fish. Lift-nets.	Selected underwater blasts in June, August and October.	During 1985	Selected intervals from blast centre.
3. To determine the effectiveness of environmental protection features incorporated in the design of Darlington NGS.	Diffuser effects.	To assess the response of fish populations to the operation of the diffuser.	(i) Gill nets (ii) Acoustic census	(i) Once in January to supplement regular fishing. (ii) As above.	(i) Once during preop phase (1986-7) and once during 2 unit and 4 unit operation. (ii) As above.	As indicated above for regular fishing.
	Cooling water intake effects: (a) Entrapment*	To assess the performance of the intake in diverting fish from entrapment. Assessment of fish abundance and behaviour near intake.	(i) A fixed, continuously recording sonar scanner. (ii) Diver observation, underwater video.	Once in May, August, November and January.	Once during preop phase (1985/6 or 7), and once during 2 unit and 4 unit operation.	Intake area.
	(b) Entrainment**	To assess rates of larval fish and zooplankton entrainment in relation to observed lake densities near the intake.	Plankton nets.	Twice weekly from April to August.	Once during preop phase (1985 or 8), and during 2 unit and 4 unit operation.	In forebay and near intake (depth-stratified samples).

* Hydraulic Studies Department to concurrently measure approach velocities across intake (profile).
** Hydraulic Studies Department to concurrently measure water trajectories leading to intake.

TABLE 2
ACTIVITY SCHEDULE FOR DARLINGTON AQUATIC STUDIES

Year	Gill Nets	Larval Whitfish	Acoust Surv	Benth Pred	Sed Move	Sed Rad	Int Ent	Int Entrap	Egg Inc	Const Sed	Blasting Effects
1984 (Pre 1)	X	+whitefish fecundity(2)			X						
1985 (Pre 2)	X	X	X	X(1)						X	X
1986 (Pre 3)	X	X	X	X(1)	X(3)	X	X				
1987 (C 0-1)	X	X(3)		X(3)	X	X(3)		X	X	+Trap net(2)	
1988 (C 1)	X	X		X	X	X					
1989 (C 1-2)	X	X		X	X	X			X		
1990 (C 2)	X	X	X	X	X	X		X			
1991 (C 3)	X	X		X	X	X	X				
1992 (C 3-4)	X	X		X	X	X					
1993 (Post 1)	X	X		X	X	X			X		
1994 (Post 2)	X	X	X	X	X	X		X			
1995 (Post 3)	X	X		X	X	X	X				

Notes:

- (1) = not completed due to equipment problems
- (2) = additional new study
- (3) = modification of procedures or test of new method

extends about 800 m offshore and connects to a 900 m long discharge diffuser. Cooling water will be discharged from 90 ports on the lake bottom (located 10 m apart). Water depth ranges from about 10 m to 12 m along the diffuser line. The diffuser is about 500 m (shortest perpendicular distance) west of the intake (Fig. 1).

The diffuser mixing zone is defined as a 1 km² area within which turbulent mixing occurs, and which defines the location at which plumes must be mixed to 2°C above ambient. At the offshore end of the diffuser, the mixing zone radius will approximate 450 meters, and will be about 250 meters at the inshore end of the diffuser.

Most of the aquatic monitoring was conducted in the vicinity of the intake and the diffuser. Initially, control sites were chosen off Port Darlington and McLaughlin Bay, but in 1984, these were relocated closer to Darlington NGS (3 km east and west) due to interference by gill nets with local boat traffic.

3.0 METHODS

3.1 Monitoring Abundance of Adult and Juvenile Fish - Gill Net Survey:

As in 1984, gill nets were used to sample adult and juvenile fish within the diffuser mixing zone and at reference locations west and east of Darlington NGS. Gill net sampling in 1985 was reduced from 1984 levels, both to limit expenditures and reduce sampling mortality on salmonid and whitefish populations. During each netting session, surface and bottom nets were set near the inshore and offshore ends of the diffuser. Bottom and surface nets were also set at the east and west reference locations.

Set locations in the vicinity of the diffuser included the sites at the inshore (Site A; 7-10 m) and offshore (Site D; 12-15 m) ends of the diffuser line, as used in 1984 (Figure 1). During 1984, interference with local boat traffic resulted in alteration of the reference fishing locations in November and December. The reference locations used in 1985 were those used in late 1984. Thus, the east reference location (Site H) was moved from Port Darlington (7 km east of Darlington NGS) to a location 3 km east of the station (Figure 1). The west reference location (Site F) was 3 km west of the station, instead of the former McLaughlin Bay site (5 km from the plant). At each reference location, surface and bottom nets were set leading offshore from the 10 m depth contour, reaching a maximum depth near 12 m. The loran C positioning system was used to establish a system of marker spars which were used throughout the netting season. Spar positions were also fixed using the GHE mini ranger to allow accurate relocation of these sites in future.

As in 1984, each gill net consisted of 8 panels, with mesh sizes ranging from 3.8 cm (stretched mesh) to 12.5 cm. Within each net, panels were arranged in increasing order of mesh size. Sets were made perpendicular to shore. No attempt was made to orient the nets with regard to mesh size. Thus, the location of small or large mesh ends of the nets was random with regard to distance from

shore. Nets were set for a 24 hour period at each location. Each site was scheduled to be fished twice in May, July, October and November and once in December. However, due to inclement weather, only a single set of samples was obtained in November.

Collection of meristic data and scale samples followed procedures used in 1984. Also, surface and bottom temperatures were recorded at the time of setting and lifting of each net.

3.2 Acoustic Fish Census:

An acoustic fish census was done in 1985. This will be repeated in 1986 (second pre-op census), once in the commissioning phase during two unit operation, and once when the station reaches full operational status (four units), as outlined in Table 2. The acoustic census has the following objectives:

1. To detect major changes in relative abundance in the discharge mixing zone. Comparisons will be made spatially (discharge vs reference areas) and temporally (across years).
2. To assess response of fish to operation of the diffuser (spatial distribution vs currents and temperature).
3. To assess distribution of fish relative to the PPB cooling water intake (both horizontal and vertical distribution). These data will complement scanning sonar and diver observations in the intake area planned during future years (Table 1 & 2).

The acoustic census involved detailed echo sounding within a 1.5 km area containing the diffuser and intake structures, extending from the 5 m contour offshore for at least 2 km (Figure 1). Within this area, 11 transects were run (spaced 150 m apart). An additional transect was also run perpendicular to the general grid which crossed the intake structure. Limited sounding (three transects at each site) was conducted for similar distances offshore at each of the east and west reference sites used for gill net surveys (Figure 1).

The acoustic survey was scheduled to be repeated twice (July, November) during 1985. In subsequent study years, a May acoustic survey will be included. The May survey in 1985 was not undertaken due to the expected disturbance from intake excavation (blasting and dredging). The July survey was completed as scheduled, but a malfunction of the sonar equipment (which could not be repaired on site) at the start of the November survey prevented us from carrying out the November acoustic work.

In each survey period, there were two daylight runs and one night run over the entire acoustic grid. Ancillary gill netting was used to aid in identification of observed fish echoes. Data from regular gill net surveys (which generally coincided with scheduled acoustic survey periods) could also assist in identification of fish echoes.

3.3 Predation By Pelagic Fish:

One of the hypotheses of effect developed at the Darlington Workshop was that displacement of benthic invertebrates and demersal fish larvae would result from diffuser entrainment, making these organisms more vulnerable to predation from pelagic fish attracted to the diffuser area. Consequently, stomach contents of pelagic fish collected from the diffuser area and reference locations will be analyzed 3 times per year (May, July, September). Fifty fish (smelt or alewife) will be collected in each time period. Stomachs will be analyzed in the laboratory, paying particular attention to food items of benthic origin.

This survey will be repeated annually, starting in 1986. In 1985, only minor technique development was undertaken. This involved testing a suitable collection method, as normal gill net caught fish are likely to regurgitate stomach contents. A large tow net (approximately 2 m in diameter, made with 1 cm mesh) was constructed to collect smelt or alewife in near-surface waters at dusk. The net was not completed until late September, and tests in September - October did not yield any fish. As it was not clear whether the poor results were caused by a lack of alewife at this time, it was decided to further test the net in 1986.

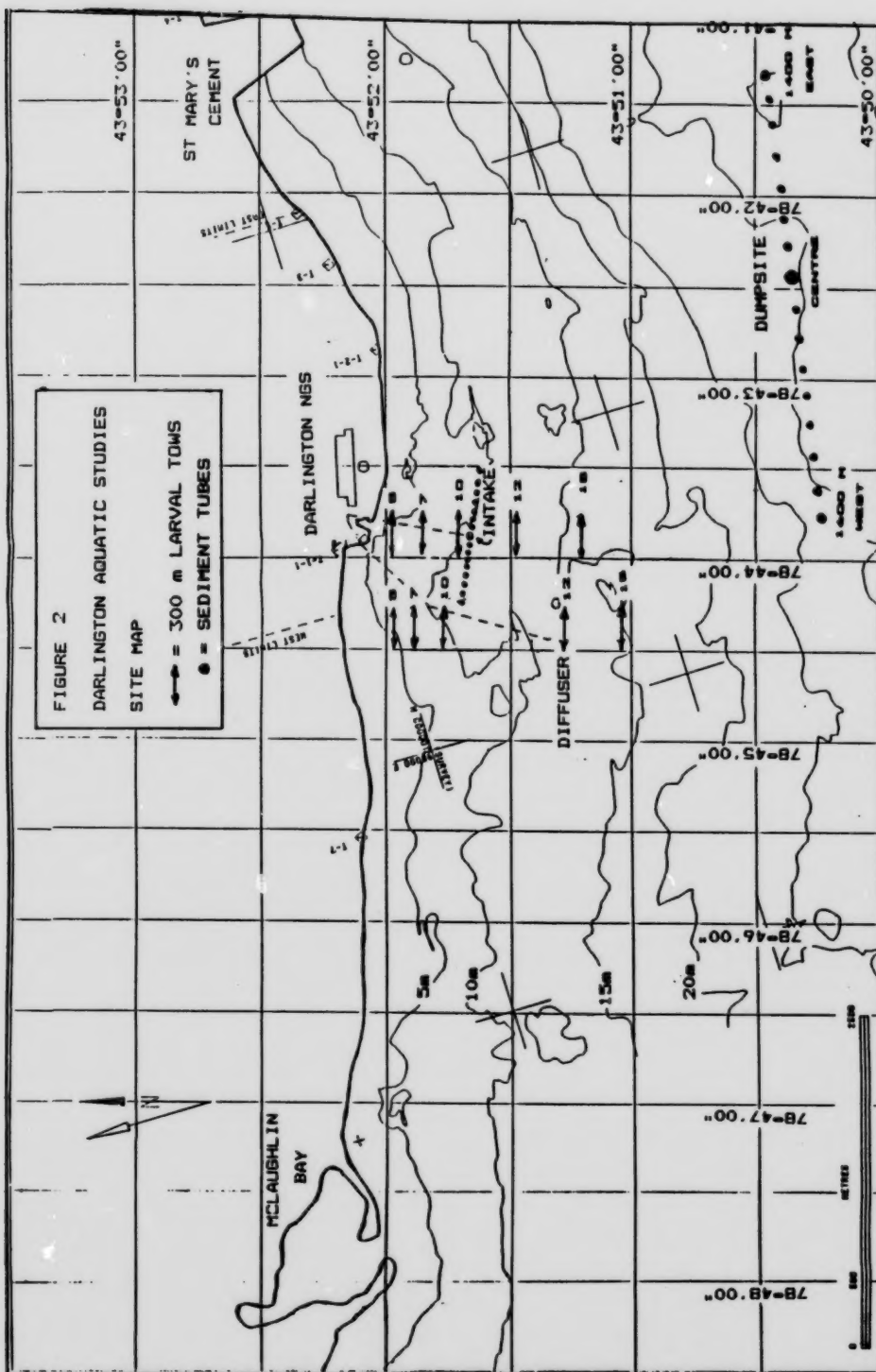
3.4 Density of Larvae from Fall - Spawning Fish:

Attempts were made to determine the density of larvae from fall-spawning fish species (primarily round whitefish), with a view to assessing reproductive success in thermally altered areas and the potential for intake entrainment. Larvae were sampled over a four week period beginning in mid-April. Twice weekly, 5 minute tow net samples (approximately 300 m in length) were taken at surface and mid-depth, using paired 0.5 m tow nets. Tows were made parallel to shore at 5, 7, 10, 12 and 15 m depth contours in the vicinity of the diffuser and intake structures. Bottom tows were made weekly at each location using the benthic sled. The sampling locations are shown in Figure 2.

A diver operated suction pump was planned to be used to collect round whitefish eggs after spawning in December. However, due to the lack of success in pumping trials at Pickering NGS during 1984-85 (Ontario Hydro Research Division Report 87-181-K), the proposed sampling at Darlington was not done.

3.5 Blasting Mortality:

Underwater blasting to excavate the PPB intake was scheduled for the mid-May to late June period. However, most blasting occurred over the late June to mid-July period. Studies at Nanticoke (Teleki and Chamberlain, 1978) suggest that substantial fish mortality may result from blasting of the type done at Darlington. To assess the damage to fish at Darlington, mortality radii were estimated during selected blasts using caged fish, and mortality estimates were made from dead fish which rose to the surface after blasts. Lift nets were also placed on bottom at various distances from the blast site. Following a blast, these were raised to the surface to collect samples of fish which may have sunk to the bottom or remained floating in the water column. Divers surveyed the bottom following some blasts to determine whether any dead fish were lying on



the bottom. In addition to tests with caged adult fish, tests were also conducted with rock bass eggs.

Two fish species (yellow perch and rock bass) were used for cage testing of adult fish. Adult yellow perch were collected with trap nets from the Lennox GS area prior to blasting and held in a 3.7 m diameter pool equipped with a continuous flow of lakewater. The pool was set up near the loading dock at Darlington NGS. It was planned to test both adult perch and eggs, but due to the delay in the blasting program, the perch spawning period was well past once blasting began. Hence, only adults were tested.

Tests began shortly after blasting started. Adults were transferred to mesh cages (trap net material) for exposure to the blasts. From 5 to 10 fish were used in each cage, depending upon availability. Cages were located at distances of 25, 50, 100, 150, 200, and 250 meters from the blast site. Additional control cages were located 1000 m from the blast. Cages were placed perpendicular to the excavation face, to maximize blast effects. During some tests, blast pressures were monitored by Geotechnical Engineering staff, who placed pressure recording equipment at two of the sites occupied by fish cages. Cages were placed 1 to 2 hours before a blast and retrieved within one hour after detonation. Following an initial examination, surviving fish were returned to the holding tank for additional post-blast observation. In the tank, adult fish from each test were held in small (22 liter) perforated plastic containers. Post-test mortality observations were made daily for a 96 hour period. It was planned to conduct three replicate tests with yellow perch adults and eggs, but due to limited fish availability and the compressed blasting schedule, only two replicates were completed.

During July, similar tests were conducted using rock bass adults. However, it was only possible to finish one replicate test prior to completion of the blasting schedule. This test was conducted with fish captured in the vicinity of the Bruce Nuclear Power Development on Lake Huron. Due to some damage and stresses associated with capture and handling, these fish were in poor condition at the time of testing. Consequently, considerable mortality was observed in all treatments (including controls). A single test was also conducted with freshly fertilized rock bass eggs (also obtained from the BNPD site). Bass eggs (25 eggs/chamber) were placed in cylindrical stainless mesh cages (1 mm mesh). These cages, which measured approximately 12 cm diameter by 25 cm in length, were used for whitefish field incubations at Pickering (Ontario Hydro Research Division Report 87-181-K). Egg cages were located at distances of 25, 50, 100, 150, 200, 250 and 1000 meters from the blast site. Following the blast, the eggs were transferred (in the mesh cages) to the holding tank for observation. As the incubation period of rock bass is extremely short, it was expected that surviving eggs would hatch during the post-blast observation period. Most hatch occurred between 24 and 48 hours after the blast.

Throughout the blasting period, effects on local fish populations were assessed by means of lift nets and post-blast visual inspections. Ten fine mesh lift nets (each approximately 2.5 m by 2.5 m) were placed at 5 locations (2 nets/location) ranging from 25 m to 200 m from the blast center. Within 30 minutes of detonation, the nets were lifted vertically to the surface to collect any dead

fish lying on the bottom or floating in the water column. Usually, all nets were retrieved within 15 minutes. Five blasts were monitored in this manner. These data were supplemented by post-blast inspections of fish floating on the water surface (6 blasts). Post-blast inspections were also conducted by divers on three occasions.

3.6 Sedimentation Resulting From Intake Construction:

Construction of the PPB cooling water intake was expected to result in some sediment deposition in areas around the intake as well as around the offshore dump site. Predictions (Ontario Hydro Design & Development Report 84306) suggest that ambient currents will result in greatest deposition in directions alongshore (east and west) from these two sites.

The initial sediment deposition patterns were quantified by means of sediment collecting tubes set out parallel to shore east and west of both the intake excavation and the dump site (Figure 2). Sediment tubes were set (4 per site) at distances of 50, 100, 150, 200, 250, 300, 400, and 500 meters on each side of the intake excavation.

At the dump site, wider dispersion was expected due to the greater depth (24 m). Therefore, sediment tubes at the dump site were located at distances of 200, 400, 600, 800, 1000, 1200, 1400 and 1600 meters on the west side of the dump site margin. One set of tubes was placed at the dump site centre, and east of the dump site, tubes were located at distances from 200 to 1400 m from the dump site (Figure 2). Tubes were initially set in May, then retrieved and replaced monthly until November. Continuation of sampling beyond the June - July construction period should provide some indication of subsequent resuspension and dispersion of excavated sediments. However, adverse weather and difficulty in finding some tubes resulted in only partial sample recovery after September.

Data obtained from each sediment tube included total dry weight (air dried at 60°C), % organic matter (loss on ignition at 550°C) and particle size distribution. Sediment tubes used in the vicinity of the intake were set and retrieved by divers. However, as the depth at the dump site (24 meters) precluded the use of Ontario Hydro divers, weighted tubes were set and retrieved by ropes from the surface. Spar buoys were used to mark sediment tube locations.

4.0 RESULTS AND DISCUSSION

4.1 Gill Net Survey of Adult and Juvenile Fish:

During the May to December period, 64 twenty-four hour gill net sets were completed, yielding a total catch of 8,659 fish. Catch data for bottom and surface nets are listed in Appendices 1 and 2, respectively. Alewife numerically dominated the catch, with 8,074 fish contributing 92.25% of the total catch. Round whitefish (196 fish - 2.26%) was the second most abundant species, followed by lake trout (106 fish - 1.22%), white sucker (72 fish - 0.83%) and brown trout (49 fish - 0.57%). Other salmonids collected included 26 rainbow trout, 15 coho salmon and 5 chinook salmon. The majority of salmonids caught were returned alive to the lake. Only 46 rainbow smelt (0.53%) were collected, compared with

853 smelt in 1984.

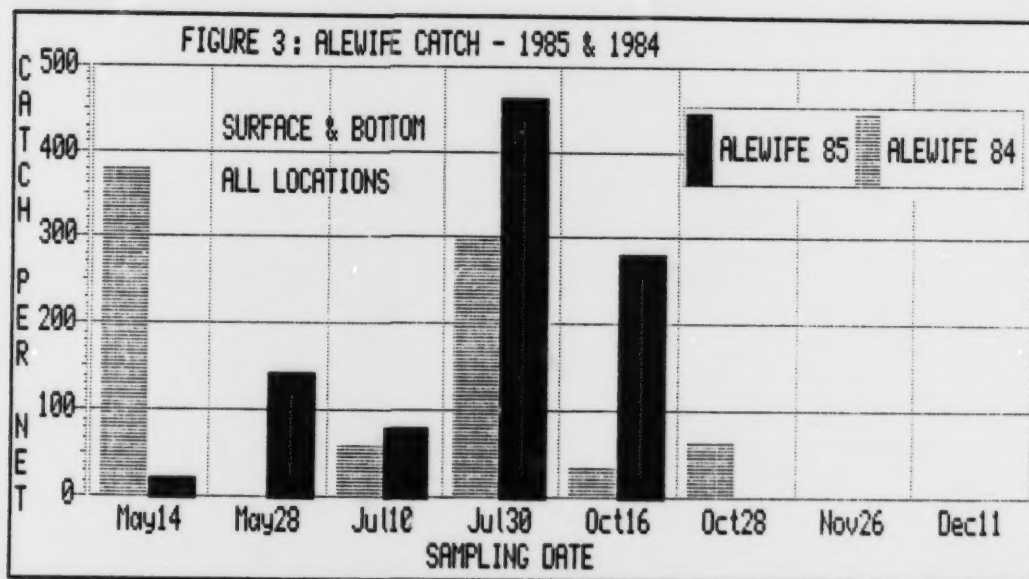
The seasonal distribution of the alewife catch is shown in Figure 3. During 1985, peak catches occurred in late July and mid-October. Few alewife were taken in early May or after October 16. The 1984 catches (shown for approximately comparable dates) differed, as the largest catches occurred in early May and few fish were taken in October, although large catches were taken during late July in both years. The average alewife catch per net was somewhat higher (126.2/net) during 1985 than during 1984 (85.3/net).

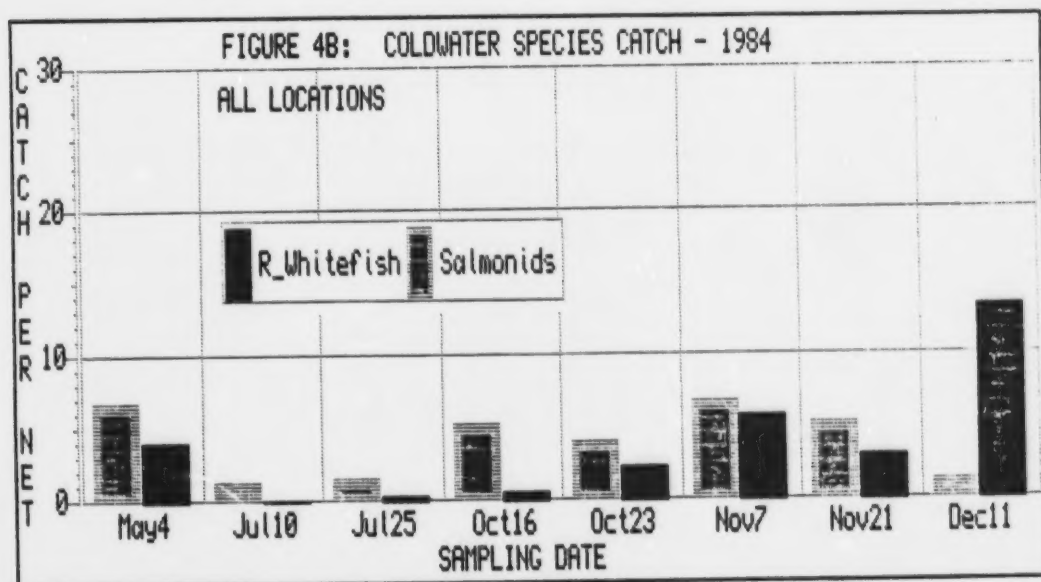
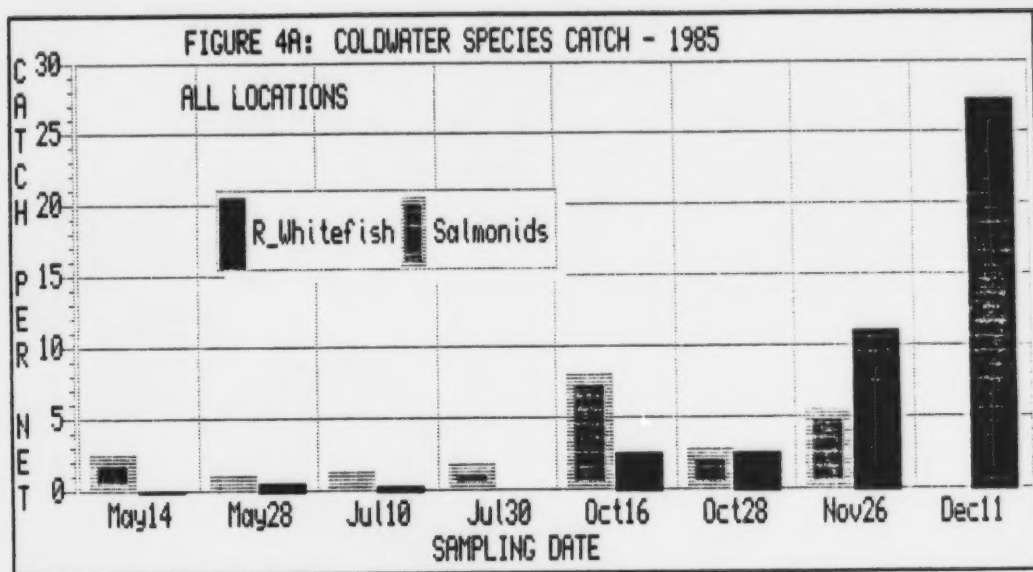
Catches of the coldwater species (round whitefish, salmonids) are shown for both years in Figure 4. The seasonal catch distribution for round whitefish was very similar in both years, remaining low until mid-October, generally increasing through November, then rising sharply during the December spawning period. The catch during late November and December of 1985 (Figure 4a) substantially exceeded that obtained during this period in 1984 (Figure 4b). Over the entire 1985 sampling year, the average catch (only bottom nets considered) was 5.72 whitefish/net, while it was 3.95 whitefish/net in 1984. The temporal pattern of salmonid catches was similar in both years (Figure 4). Moderate catches were obtained in early May and only a few salmonids were taken in July. Salmonid catches were highest (3 to 8/net) over the October to November period, but most had left the area by December. The average salmonid catch (both surface and bottom nets considered) was somewhat lower (3.14/net) in 1985 than in 1984 (4.14/net).

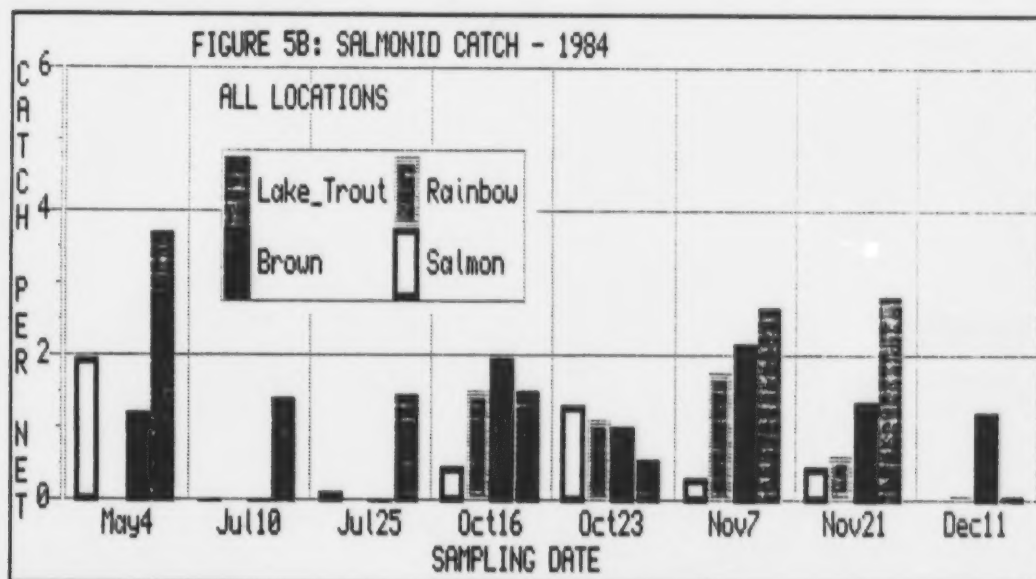
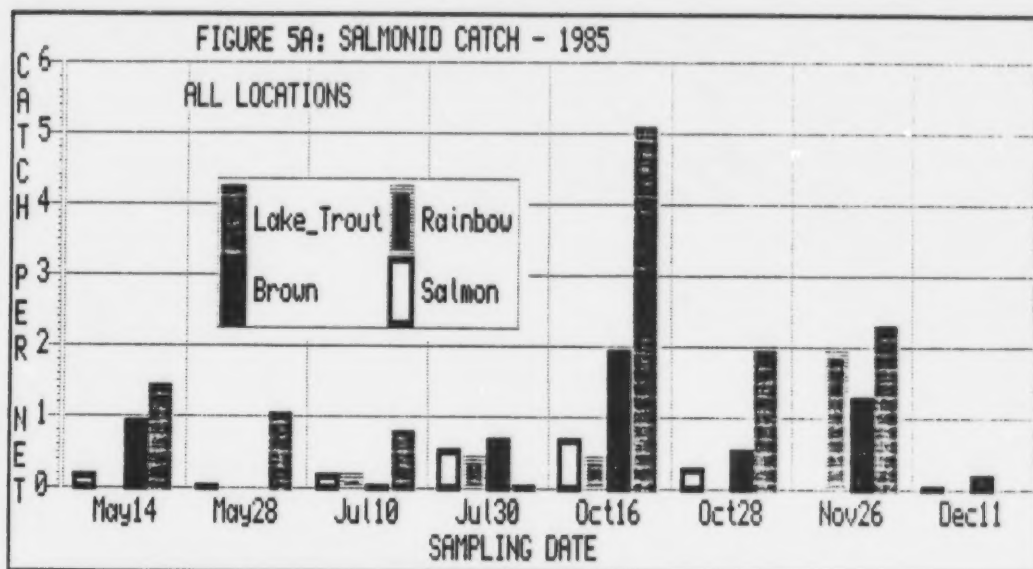
The seasonal catch of salmonids is shown in detail in Figure 5. During 1985, lake trout catches declined over the May to July period (Figure 5a). Peak catches (from 2 to 5 fish/net) occurred over the October to November spawning period, and no lake trout were taken in December. In 1984, the largest lake trout catches occurred in early May (Figure 5b). Catches were moderate (about 1 fish/net) through July and October of 1984, then rose (2.5 to 3 fish/net) in November. Again, lake trout appeared to have left the nearshore area by the time of the December, 1984 sampling. Yearly average lake trout catches in 1985 (1.66/net) were very comparable to the 1984 catches (1.73/net).

During 1985, brown trout were taken on all sampling occasions except the late May period. The majority of brown trout were taken during October and November (Figure 5a). A similar temporal catch pattern was observed in 1984 (Figure 5b), but the average catch in 1985 (0.77/net) was somewhat lower than the 1984 catch (1.13/net). Catches of rainbow trout in 1985 (0.41/net) were lower than in 1984 (0.77/net). Catches of salmon in 1985 (mostly coho) were also lower than in 1984 (0.31/net vs 0.51/net). These salmonid species were taken during most sampling periods, but catches were generally highest during October or November.

The spatial distributions of catch for the most common species are considered next. The average alewife catches for surface and bottom nets are shown in Figure 6. In order to assess whether the differences shown in the figure were statistically significant, results were subjected to a two-way Analysis of Variance, using a randomized block design. In this analysis, the individual sampling periods were treated as blocks, effectively removing the large seasonal variation present in the data. Results using log(n+1) transformed data (Appendix





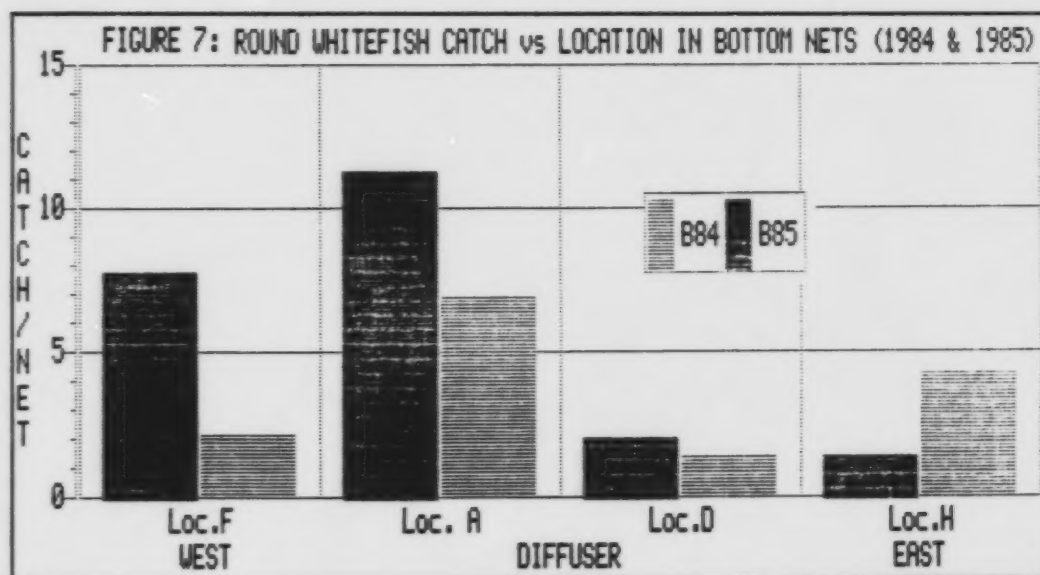
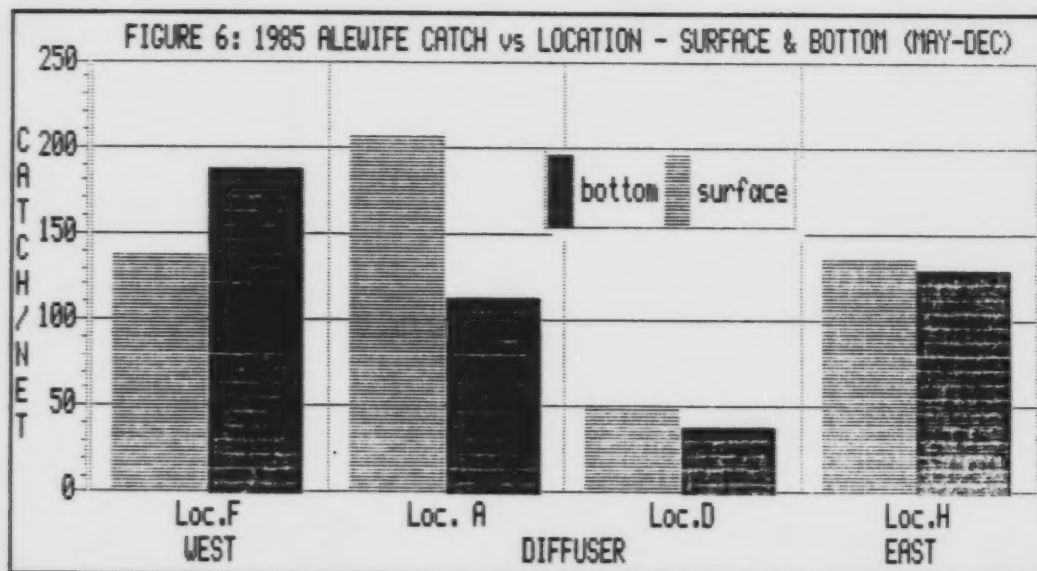


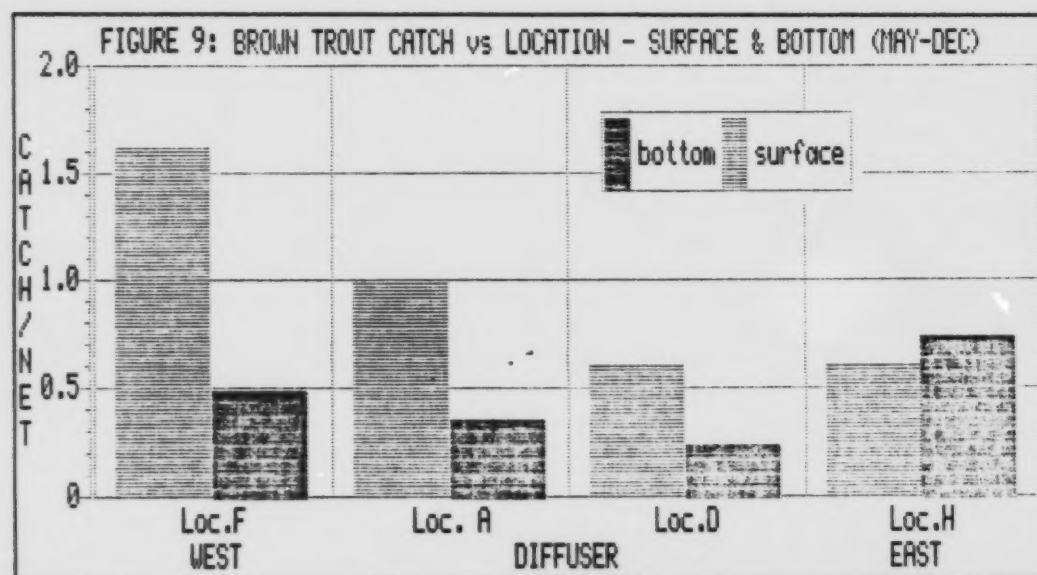
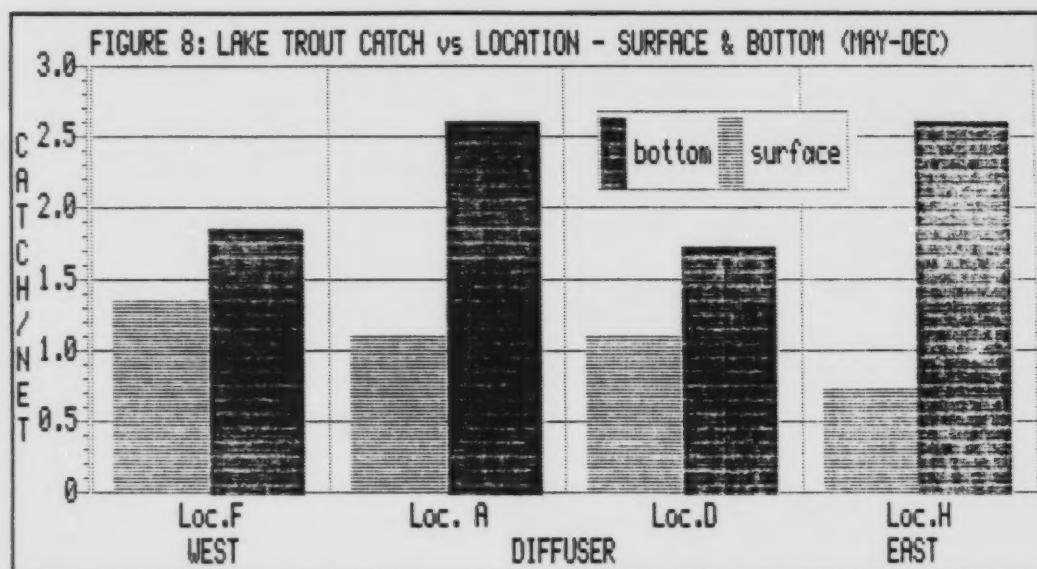
11A) indicated that there was no significant difference ($F_{1,49} = 1.35$) between surface catches (133/net) and bottom catches (119/net). However, there was a significant difference in catches at the various locations ($F_{3,49} = 4.34$). The follow-up multiple comparison (Duncan's Test) indicated that the catch at location D (45.7/net) was significantly lower than that at all other sites. Catches at locations F (163.9/net), location A (160.4/net) and location H (134.6/net) did not differ significantly (Appendix 11A). It should be noted that these results differ somewhat from 1984. In that year, when 8 sites were sampled, more alewife were taken in bottom nets than in surface nets, and the diffuser sites (A to D) had lower average catches than the reference sites (E to H). However, incomplete sampling during the spring (when substantial catches were taken at the diffuser) precluded the type of analysis used with the 1985 data.

During 1985, round whitefish were collected in surface nets only during the December 11 sampling, when the largest catches were taken in the bottom nets (Appendices 1, 2). During 1984, round whitefish were collected only from bottom nets. Analysis of the 1985 catch data (Appendix 11B) indicated that the bottom net catch was significantly larger than the surface catch ($F_{1,49} = 21.5$). The average catches at each location in bottom nets during 1984 and 1985 are shown in Figure 7. The plot suggests that the highest average catch in each year was taken at location 'A', the inshore end of the diffuser, while the lowest catches were taken at site 'D' (the offshore end of the diffuser) and site 'H' (the East reference). However, analysis of the results (location x year with sampling periods as blocks) indicated no significant effects for either year or location (Appendix 11C). It was believed that this was due to the very low catches (many zero values) during the spring and summer sampling. As the prime interest in round whitefish is associated with abundance during the fall spawning period, data for this period (October to December) were analyzed separately. The analysis (Appendix 11D) indicated that the difference in mean fall catch (5.5/net in 1984 vs 11.1/net in 1985) was not significant ($F_{1,21} = 2.15$). However, a significant difference ($F_{3,21} = 3.25$) was noted for sampling locations, and the location x year interaction was not significant. Duncan's Test indicated that the mean fall catch at site 'A' (16.7/net) was significantly higher than the catch at site 'H' (3.3/net). The catches at sites 'F' (9.8/net) and at site 'D' (3.4/net) were intermediate and not significantly different from either the high or low sites (Appendix 11D).

The 1985 lake trout catch data are plotted in Figure 8. Analysis of results (Appendix 11E) indicates that the average bottom catch (2.22/net) significantly ($F_{1,49} = 6.39$) exceeded the average surface catch (1.09/net). Similar results were observed in 1984, with bottom and surface catches of 2.12 and 1.11/net, respectively (only July - December catches could be compared in 1984). The average catches at the four sites sampled in 1985 ranged from 1.44 to 1.88/net. These differences were not significant. In 1984, there was no clear spatial pattern to the catch, although a large single net catch (16 fish) resulted in a high average bottom catch (>5/net) at site 'H'.

The 1985 brown trout catch data are shown in Figure 9. Although the plot suggests substantial differences in average catch at various sites (ranging from 1.06/net at site 'F' to 0.44/net at site 'D') the data were not significantly





different ($F_{3,49} = 0.85$; Appendix 11F). However, surface brown trout catches (0.97/net) significantly ($F_{1,49} = 4.68$) exceeded bottom catches (0.47/net) during 1985. In 1984, brown trout catches in surface nets (1.44/net) were also approximately double the bottom catches (0.86/net).

4.2 Acoustic Fish Census:

As described in the Methods section, only a single acoustic fish census was completed in 1985. As this survey was repeated during May, July and November of 1986, it was agreed with ES&A staff to combine the two year's data in a single report. Thus, the 1985 results will be presented with the 1986 data.

4.3 Density of Larvae from Fall - Spawning Fish:

Over the period of April 17 to May 23, a total of 438 larval fish samples (219 paired tows) was collected in the areas of the Darlington CCW intake and the discharge diffuser (Appendix 3). Approximately equal effort was expended at each site. Surface samples (156) and mid-depth samples (142) were collected with 0.5 m larval tow nets, while the bottom samples (140) were collected with the benthic sled.

Round whitefish larvae were collected over the period from April 17 to April 26 (Appendix 3). A total of eight larvae were collected. Five were in bottom tows, at depths of 5 m, 7 m (2 larvae), 10 m and 15 m. One larva was collected in a mid-depth tow, at the 5 m depth contour and two were collected in surface tows (at the 10 and 12 m depth contours). Diffuser sampling locations accounted for 5 of the larvae captured, and three round whitefish larvae were collected from the intake sampling locations. Total lengths of the round whitefish larvae captured ranged from 11.5 mm (April 17) to 15 mm (April 26).

The lack of round whitefish larvae in samples taken after April 27 suggests that the larvae may have left the area or become less susceptible to capture during May. It is suspected that sampling might have been more effective if it had begun earlier (first or second week of April). Larvae were collected on the first sampling day (April 17), but the most effective gear (the benthic sled) was not used until April 22. Round whitefish egg incubations conducted in the Pickering area over the winter of 1984-85 provide some indication of likely hatch dates (Ontario Hydro Research Division Report 87-181-K). At the Thickson Point site (furthest east from Pickering and likely not subjected to elevated temperatures), round whitefish eggs were just beginning to hatch on April 4. On the subsequent sampling date (April 17) hatch was virtually complete. Benthic sled sampling conducted in this area began on April 16, but round whitefish larvae were not captured until April 19. The last larvae (of 6 captured) was collected on April 25. During 1984 at the Thickson Point and adjacent Whitby West sites, sampling began on April 11, but round whitefish larvae (6 captured) were collected only on April 24-25 (Ontario Hydro Research Division Report 87-181-K).

The apparent delay between hatching and the dates when larvae have been captured is consistent with observations made during laboratory incubation studies (Ontario Hydro Research Division Report 80-140-K). At the time of hatch, round

whitefish larvae have a relatively large yolk sac and often remain on or near the bottom. In cobble substrates, they would likely be extremely difficult to capture, and may remain in the substrate for some time after hatch. Direct observations of newly hatched larvae in laboratory tanks indicated that the larvae preferred to remain near bottom, and preferred a sand substrate over pebble or cobble (Ontario Hydro Research Division Report 83-57-K).

Although limited, the available data (field catches, laboratory behavioural observations) suggest that during most years, round whitefish sampling on the north shore of Lake Ontario is most likely to be successful during the April 15 to April 30 period. Continuing sampling into May is unlikely to yield round whitefish larvae unless an unusually cold spring is encountered. Earlier sampling (late March to early April) may be worthwhile when Darlington becomes operational, if temperature monitoring indicates significant bottom warming in areas adjacent to the discharge. However, as the diffuser is designed to promote rapid mixing of the discharge with lakewater, "sinking plume" conditions should not occur, and bottom heating during winter should be very limited.

Sampling over the April 29 to May 8 period yielded a total of 52 smelt eggs (Appendix 3). The first smelt larva was captured on May 8, and 41 were collected by May 23. Collection of an additional 5 smelt eggs on May 23 suggests that a second spawning may have occurred. However, it should be noted that in Lake Ontario simulations based on laboratory incubations, hatch of smelt eggs spawned in mid-late April would take about 4 weeks, while hatch of eggs spawned in mid-May would take about 3 weeks (Ontario Hydro Research Division Report 78-343-K). Thus, it cannot be accurately determined whether the late (May 23) egg sample represented a later spawning, as the stage of development was not determined.

4.4 Blasting Mortality:

Surface counts of dead fish were made immediately following six blasts over the June 20 to July 9 period (Appendix 4A). It should be noted that all blasts monitored consisted of 16-hole blasts with two bags of explosives/hole. This was a standard charge used throughout the blasting operation. Alewife were the only species observed to be killed by the blasting. On one occasion a lake trout in the immediate blast vicinity was stunned, but swam off before it could be captured for examination. Alewife usually rose to the surface within a few minutes of a blast. The dead and stunned fish quickly attracted nearby flocks of gulls, and within 10 to 15 minutes, no alewife were left floating on the surface. Visual estimates indicated that alewife were killed at distances up to 200 m from the blast site, with a total kill radius ranging from 50 to 75 meters (Appendix 4A). Estimates of numbers killed or stunned ranged from 300 to 2000 fish/blast, with an average estimate of 930 fish.

In order to determine whether the surface counts accurately represented the total kill of fish, lift nets were retrieved from the bottom (2 per site) at distances from 25 to 200 meters from the blast and on 3 occasions, divers swam from the blast site towards shore (along the transect line used for placing cages and lift nets) for about 200 meters. Results indicated that very few of the fish killed by blasting either sank or remained in midwater (Appendix 4A). Thus, it may be assumed that almost all fish killed or stunned by the blasting rose to

the surface. As indicated, most of these fish were quickly consumed by gulls.

Results for the two experiments with caged yellow perch adults are listed in Appendix 4B. In the first test (June 21), none of the fish showed any effects immediately following the blast. All perch were swimming normally. Some mortality (1 to 2 fish/treatment) occurred during the subsequent 96 hour holding period in fish located 100 to 250 meters from the blast. However, as no mortality was observed in those fish exposed to the immediate blast area (25 and 50 meters distance), it seems unlikely that the mortality observed in the more distant treatments can be attributed to blast effects.

The second yellow perch test (June 27) resulted in some immediate effects, as all perch adjacent to the blast (25 meters) were stunned. Over the following 96 hour period, all of these fish died (Appendix 4B). Perch located at 50 to 1000 m from the blast showed no immediate effects. While substantial mortality occurred in most treatments during the 96 hour observation period, the total lack of mortality in fish located 50 m from the blast suggests that the mortalities in fish located 100 to 1000 m distant was likely not the result of blasting effects. Growth of fungus and loss of untested fish remaining in the holding tank over this period suggests that condition of the yellow perch stock was declining due to the combined stresses of capture, transport and holding. Thus, assumption that the 100% mortality in the group exposed 25 m from the blast was entirely due to blast effects is quite conservative. On the basis of the test results available, it would seem reasonable to conclude that blasting did not create lethal effects for yellow perch at distances beyond 25 meters.

A single test with caged rock bass adults was conducted on July 9 (Appendix 4C). As mentioned in the Methods section, these fish had been collected in wire mesh traps near the BNPD site on Lake Huron and transported to Darlington. They were in rather poor condition at the time of testing, but the blasting schedule (nearing completion) did not allow us time to obtain another stock of fish. Immediately following the blast, all rock bass in the 25 meter test were stunned, but bass located at greater distances were not visibly affected. Observations were continued for a further 72 hours (Appendix 4C). Sixty percent of the rock bass in the 25 m test died, but high mortality (66.7 to 90%) was observed in all other treatments, including the control located 1000 m from the blast site. This high mortality in all treatments reflects the poor condition of the test fish and prevents evaluation of longer-term effects from blasting. The immediate effects suggest that rock bass and yellow perch have similar resistance to blasting, and that severely damaging effects might be restricted to about 25 meters from the blast site.

A single test with newly fertilized rock bass eggs was conducted on July 4, 1985. It is believed that the eggs, which were obtained from natural nests at the BNPD site, had been fertilized 2 to 3 days prior to testing. There was no visible damage to the eggs immediately following the blast. Eggs were examined at 24 hour intervals, and within 48 hours, hatch was nearly complete in most treatments (Appendix 4C). Survival at hatch ranged from 50 to 76.9%, with the lowest value (50%) occurring in the 25 meter and 1000 meter treatments. Thus, these data suggest that blasting of the type done at Darlington would not adversely affect rock bass eggs. These results do not support our initial assumption that fish

eggs would be more susceptible to blast damage than adult fish.

In summary, it appears that blasting associated with the Darlington CCW intake construction resulted in a limited, local kill of alewife. Mortality was observed to a distance of about 200 meters, with a total kill occurring within 50 to 75 m of the blasts. For the six blasts monitored, the average kill of alewife was less than 1000 fish. Lift net and diver observations suggested that almost all fish killed rose to the surface shortly after the blasts. Other species appeared much less susceptible to blasting. A single lake trout stunned by a blast (only 10 m distant) appeared to recover and swam off. Cage tests indicated that substantial adverse effects on yellow perch and rock bass appeared to be restricted to the immediate blast area (approximately 25 meters) and rock bass eggs showed no adverse effects when exposed to a blast at distances from 25 meters to 1000 meters.

4.5 Sedimentation Resulting From Intake Construction:

Sediment data collected from the intake and dump site locations are reported in Appendices 5 and 6, respectively. Nearly complete data sets were obtained for both sites over the June to August period. In the fall, adverse weather resulted in considerable sample loss. The dump site sample tubes, which were attached to floating spar buoys, were particularly vulnerable to storm damage. In September, a complete set of intake samples was obtained, but dump site samples were obtained from only two locations. A complete set of samples was obtained from the intake west transect in November, but the intake east samples could not be located by the divers due to poor visibility. Some were recovered in December, but some could not be located until March, 1986 (Appendix 5). Complete sets of dump site samples were not obtained after August (Appendix 6). Only three sets of samples were recovered in September and November. A complete set of east transect samples was recovered from the dump site in December, but samples were obtained from only four of the west transect sites.

4.5.1 Intake Sediment Samples:

Sediment accumulation data for the intake site over the June to September period are shown in Figure 10. The initial set of samples (placed in mid-May and recovered on June 25-26) were subjected to intake excavation effects for only about 1 week prior to recovery (Figure 10A). Elevated sediment levels (0.022 to 0.365 grams dry weight/cm²/month) were observed only in the immediate vicinity of the intake (from 100 m west to 100 m east). The high sediment accumulation (0.365 g/cm²/month) at the site 50 m east of the intake suggests an easterly moving current during the early period of excavation. Beyond 150 m from the excavation, sediment levels in the June samples were very low, ranging from 0.0098 to 0.0040 g/cm²/month.

During the 1985 field season, the Geotechnical and Hydraulic Engineering Department operated a current meter at 8 m depth, located in 14 m of water, 1.2 km offshore along the Holt Road line (Design and Development Division Report 87554). This meter was east and somewhat offshore from the intake location and almost due north (inshore) from the dump site location. During the early period of intake excavation monitored by the 'June' samplers (approximately June 18 to

June 26), two periods of easterly currents and one period of westerly currents were observed. These current runs were 2-3 days in duration and speeds of 10-15 cm/s were observed (D&D Report 87554).

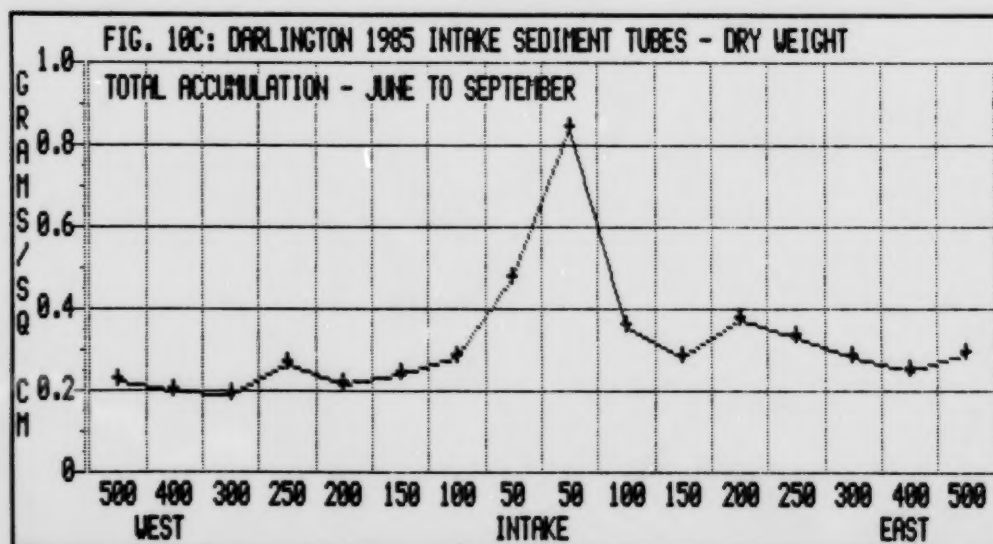
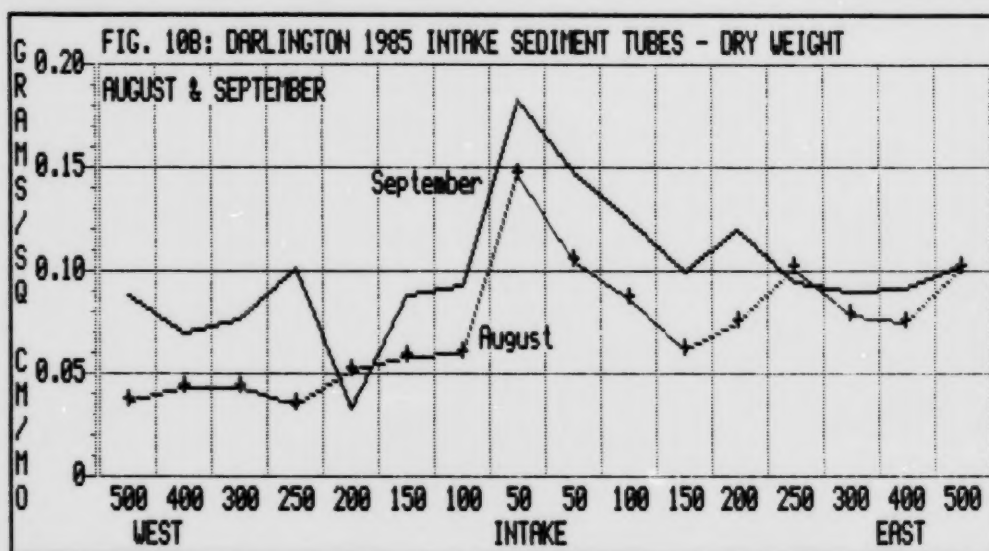
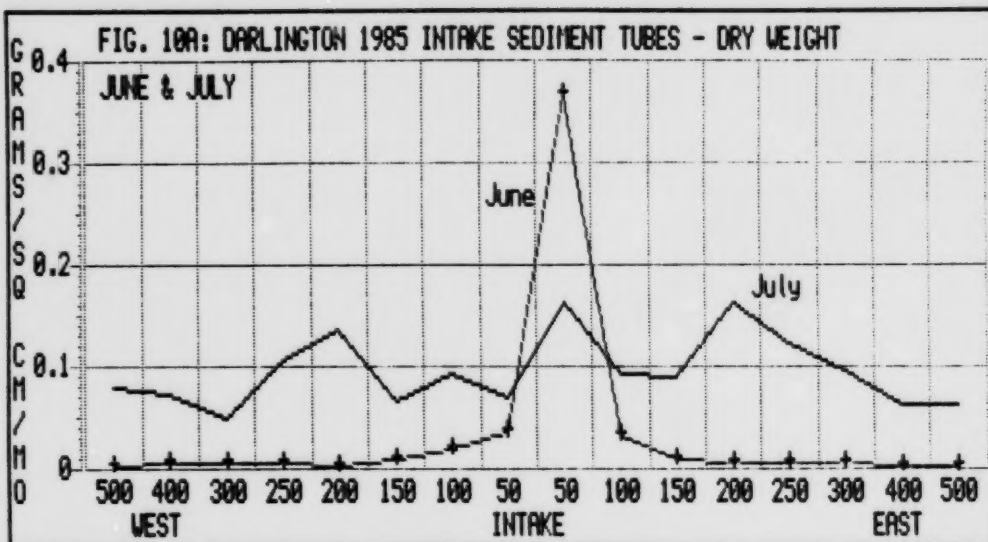
Sediment tube samples collected at the end of July (Figure 10A) generally contained more material (0.052 to 0.164 grams/cm²/month) than the June samples. Three peaks of accumulation were apparent in the data. Peak accumulations were obtained in the immediate intake vicinity (50 m east) and at distances of 200 to 250 meters (both east and west of the excavation). These results suggest that during the main period of excavation (late June to mid-July), substantial longshore currents occurred in both directions. Current data for this period indicates that flow was generally towards the west, with flows commonly ranging from 10 - 20 cm/s. Currents towards the east were observed only over the July 7 to 17 period, were generally less than 10 cm/s, and occasionally had substantial onshore or offshore components (D&D Report 87554).

Although blasting was largely completed during July, the dredging equipment remained on site until August. Thus, August data, collected over the last week of July and the first 3 weeks of August (Figure 10B) should reflect both initial deposition as well as resuspension and redistribution of the excavated sediments. Sediment accumulations ranged from about 0.04 to 0.06 g/cm²/month over the area from 500 m west to 100 m west of the excavation. Highest accumulations occurred immediately (50 m) west and east of the excavation (0.147 and 0.105 g/cm²/month, respectively). Sediment accumulations further east of the excavation ranged from 0.062 to 0.102 g/cm²/month, and were generally higher than values to the west of the excavation. However, during the August sampling period, currents consistently ran toward the west, with velocities of 15-20 cm/s commonly observed (D&D Report 87554). Easterly currents were observed only during the last week before recovery of the sediment tubes, with currents up to 15 cm/s.

Sediment accumulations in September generally exceeded those in August (Figure 10B). However, the distribution pattern was similar to that observed in August, as the greatest accumulations occurred in the immediate vicinity (50 m) of the excavation, and accumulations to the east of the intake were generally greater than those to the west. During the September sampling period, which included the last week of August and all of September, currents were characterized by alternate runs (3-5 days duration) to the east and west, with flows commonly reaching the 20-30 cm/s range (D&D Report 87554). Winds during the September sampling period exceeded those observed during the August sampling period, but did not exceed the winds observed during the June and July sampling periods (D&D Report 87554).

Total sediment accumulations over the June - September period (Figure 10C) indicate accumulations of 0.48 g/cm² at 50 m west of the intake and 0.85 g/cm² at 50 m east of the intake. At greater distances, accumulations were slightly higher to the east than to the west. Small secondary peaks of accumulation were evident 200 m east of the intake and 250 m west of the intake.

Further intake sediment samples could not be collected until November. At that time, a complete set of 'intake west' samples was obtained, but the 'intake east'



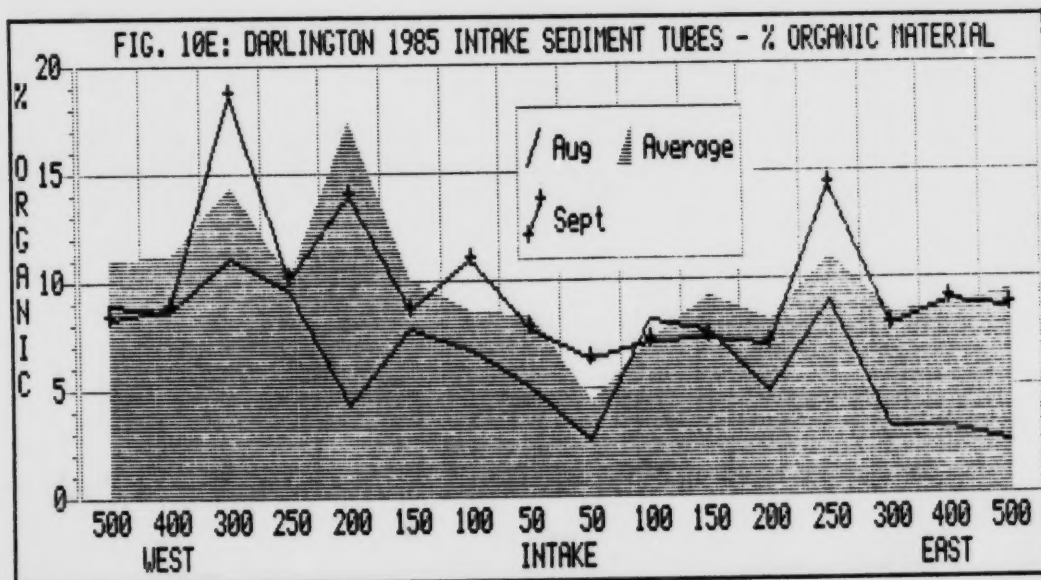
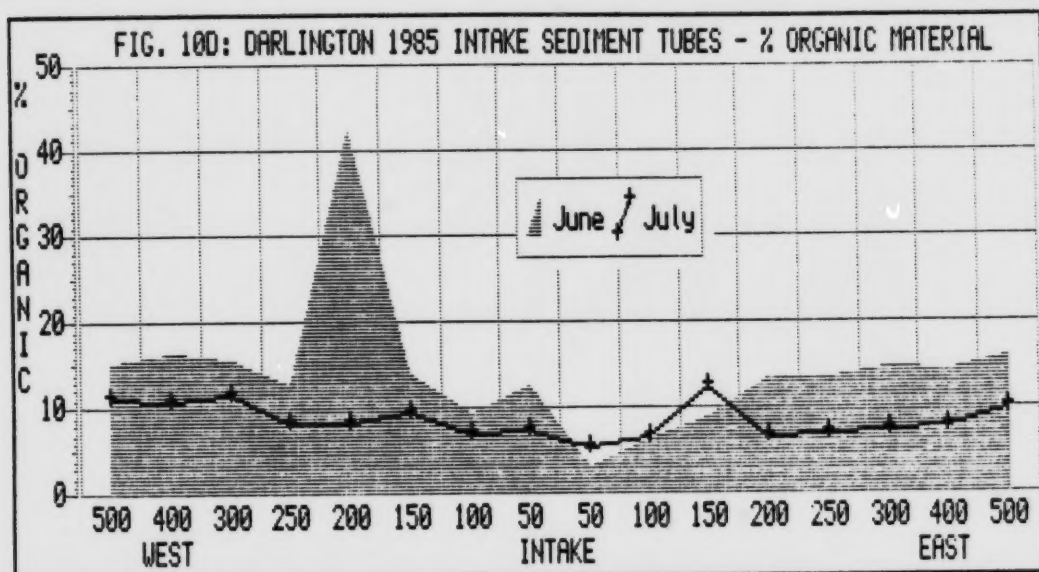
tubes could not be located, as the spar buoy marking the eastern end of the transect had been carried away by storms, and water clarity was very poor. Some of the intake east sediment tubes were located by divers and recovered in March, 1986. The intake west samples collected in November contained from 1.40 to 2.76 grams of sediment/cm²/month, well in excess of the total accumulation over the June to September period (Appendix 5). There was no obvious relation between location and sediment accumulation. Apparently, the large sediment movements associated with fall storms had obliterated the deposition patterns created during intake excavation.

The percentage of organic material (determined by loss-on-ignition) is listed for the intake samples in Appendix 8. A plot of the June results (Figure 10D) indicates that the organic content of most samples ranged from 10 to 15%. The organic content of the samples from the 200 m west site was unusually high (42%). The lowest organic content (3%) was associated with the largest sediment accumulation (at 50 m east of the intake). It would be expected that excavation of the intake (removal of bedrock and overlying glacial till) would result in deposition of sediments with a low organic content. Thus, presence of low organic content should be a reasonable indication of sediments originating from the intake excavation. As organic contents were also low (<10%) at the sites 100 and 150 m east, it appears that the general movement of sediments was towards the east during the early period of intake excavation.

It should be noted that the organic content of the settling tube samples reported here is considerably higher than that typically found in nearshore bottom 'grab samples' taken along the north shore of Lake Ontario. For example, the average organic content of sediments collected near Pickering NGS for radionuclide analysis (top 5 cm collected by divers) approximated 1% (Ontario Hydro Research Division Report 88-201-K). As the openings of the settling tubes used at Darlington were about 60 cm above the substrate, material collected would be more representative of sediments suspended in the water column ('littoral drift' plus material from excavation), especially during the low-energy summer period. During the stormy period of the year (fall-winter-spring), settling tube samples would typically be much larger, contain more large particles, and have much lower organic content, due to resuspension of surficial sediments.

In July (Figure 10D), sediment organic levels (6-11%) were somewhat lower than in June, a result expected due to the generally higher deposition levels occurring in July. Again, the lowest organic percentage was associated with the sites immediately east of the intake excavation.

Organic content of the August samples (Figure 10E) ranged from 3 to 11% and was somewhat lower than in July samples. Organic content was generally lower to the east of the intake excavation, where total sediment accumulations generally exceeded those to the west (Figure 10B). Thus, the assumption that excavated materials moved towards the east during August is supported by the organic content data. In September (Figure 10E) average organic contents were considerably higher, almost reaching June levels. Again, lowest organic contents were associated with the immediate intake area, and levels were generally lower to the east of the excavation, where total sediment accumulations were higher (Figure 10B). The general increase in both total sediment accumulation and



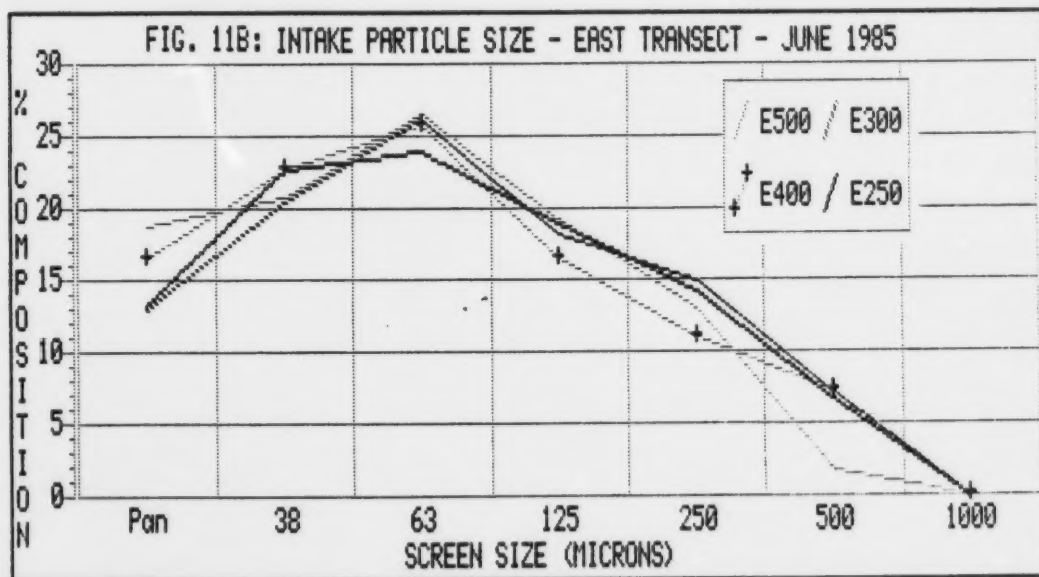
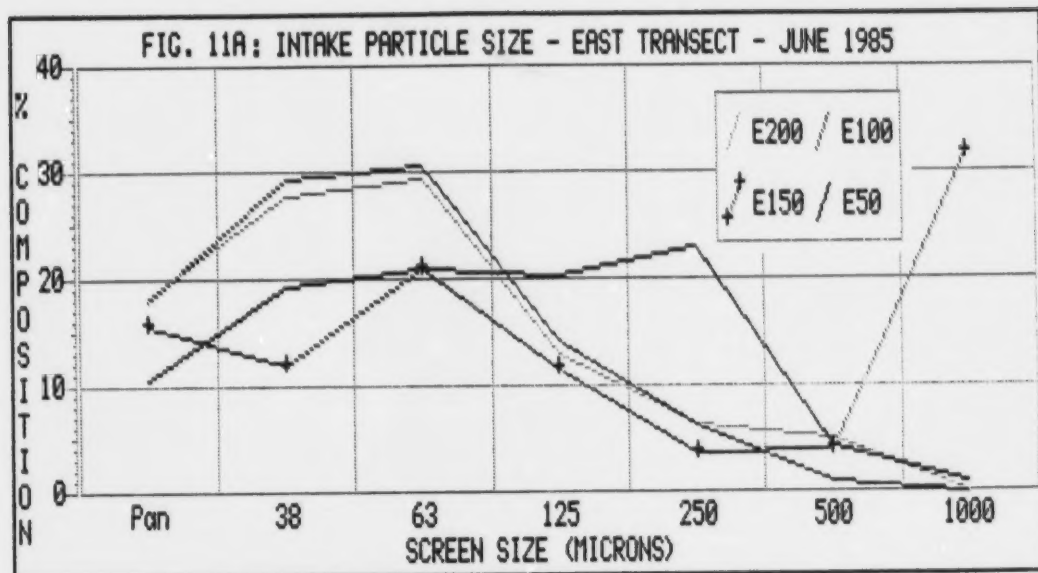
organic content from August to September suggests that the higher current flows noted in September may have increased the movement of 'natural' bottom sediments in the sampling area as well as redistributing the recently deposited sediments from the intake excavation.

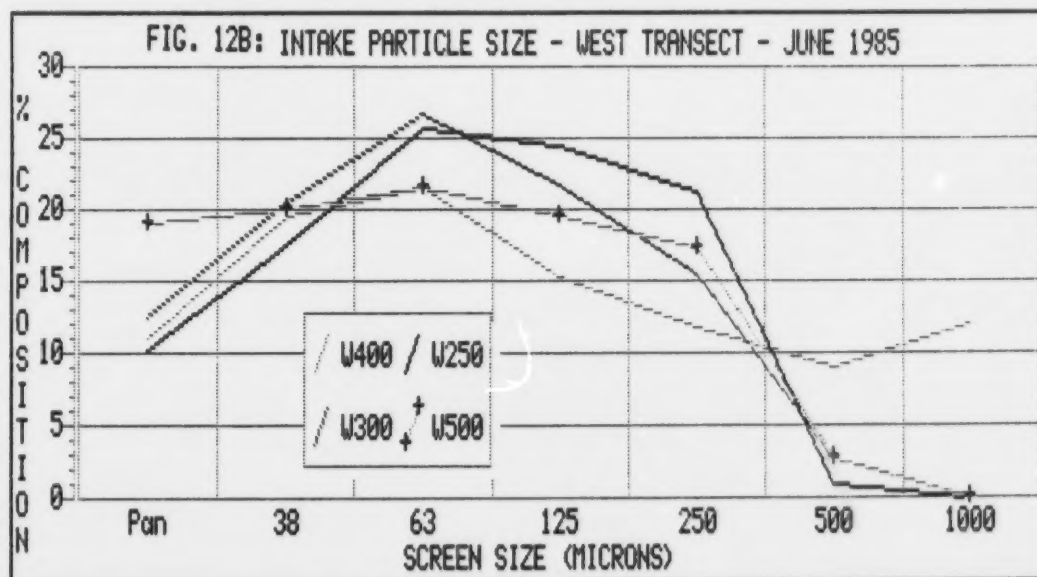
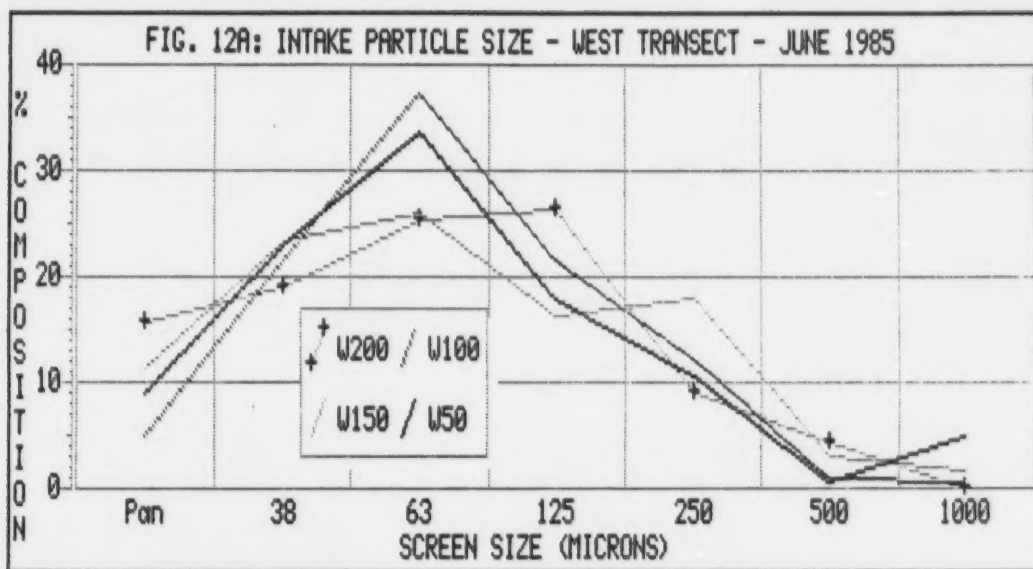
Particle size distribution data for the intake samples are listed in Appendix 9. Data for June east transect samples are plotted in Figure 11. In the figure, the values shown are the percentage (by weight) of the sample retained on each screen. Thus, for example, material retained on the 38 micron screen would measure between 38 and 63 microns in diameter. The sample from the site 50 m east of the intake differs from most other locations, as amounts of sediment on the 125 and 250 micron screens were considerably higher than at the other sites (Figure 11A). At this site, total sediment accumulation far exceeded that at any other location (Figure 10A). At other east transect sites in June, materials retained on the 38 and 63 micron screens made up the bulk of the sediment samples (Figures 11A, 11B). Results for the east 150 m sample appear somewhat anomalous, as a high percentage (32%) of large particles (>1000 microns) was observed. However, as these samples were very small (Figure 10A), the presence of only a few large particles could substantially affect results. Total sediment accumulations were low at all sites to the west of the intake in June (Figure 10A). Particle size distributions for these samples (Figure 12) indicate that this material was generally fine-grained, as most was retained on the 63 micron screen. July sediment samples showed a particle size distribution similar to the June samples, as the greatest amount of sediment in most samples was retained on the 63 micron screen. Results for the east transect are shown in Figure 13.

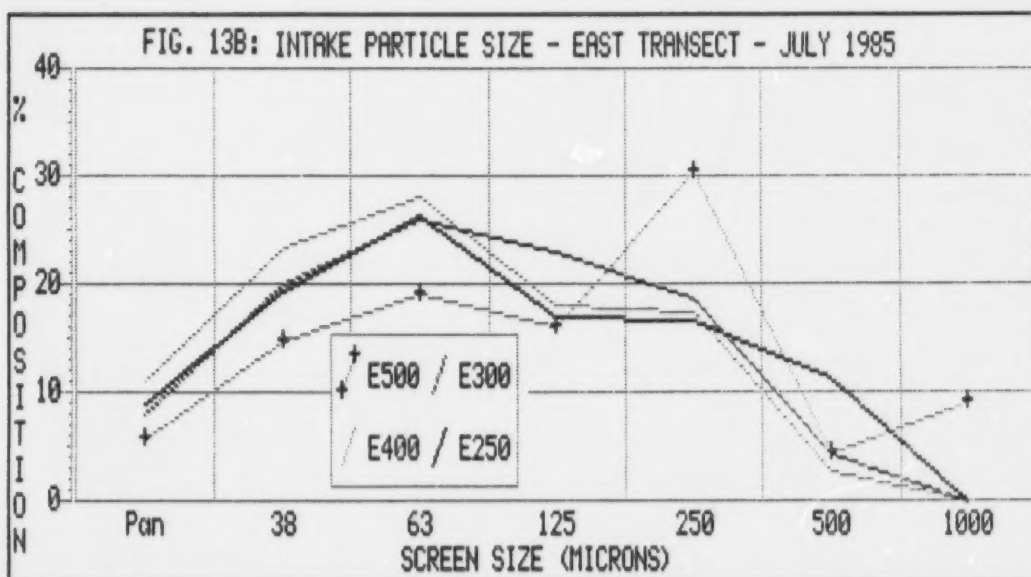
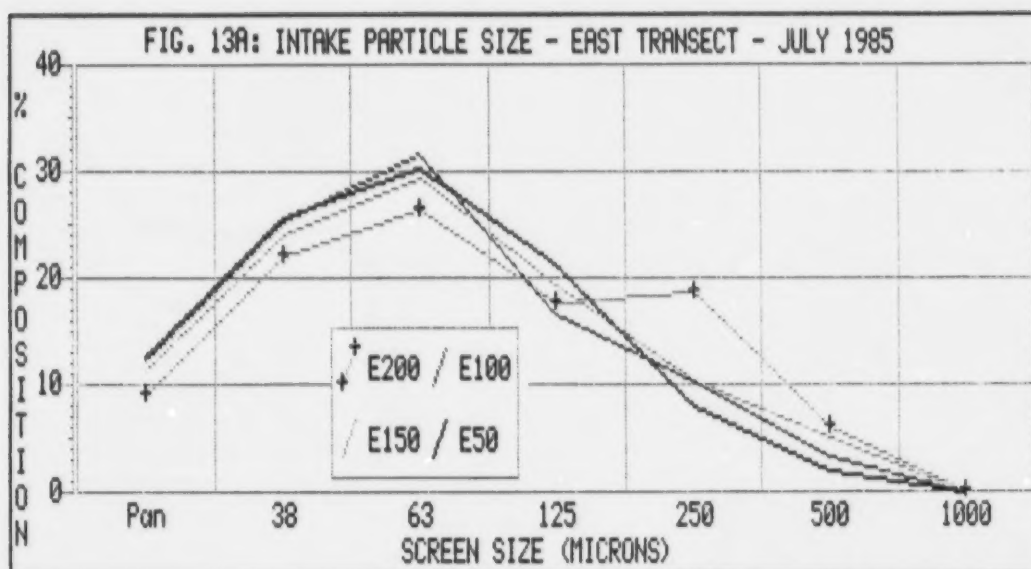
A shift towards larger particle sizes was apparent by August (Figure 14). This was most evident for samples on the east transect, at distances from 250 to 500 m from the intake (Figure 14B). These samples were dominated by particles retained on the 250 micron screen. Samples collected to the west of the intake displayed two size distributions (Figures 14C, 14D). Some samples were fine-grained and similar to the June-July samples, while others were similar to the coarse-grained samples collected east of the intake. There was no apparent correlation between the particle size distribution and the distance from the intake in the west transect samples.

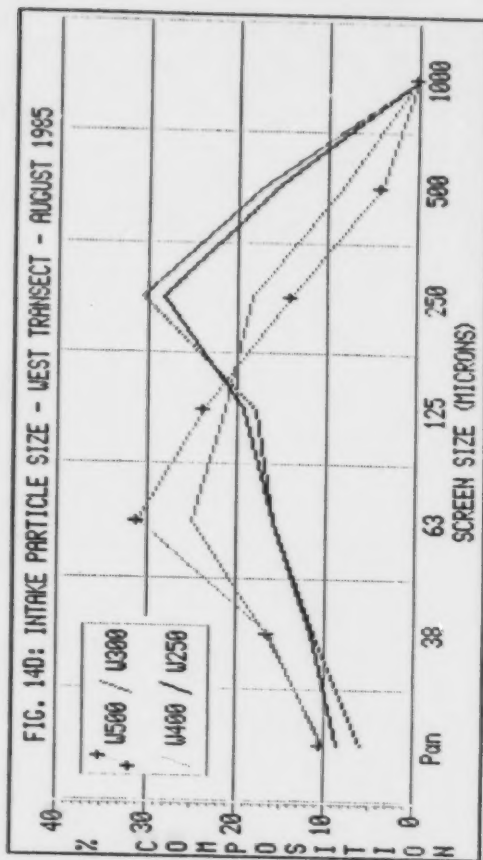
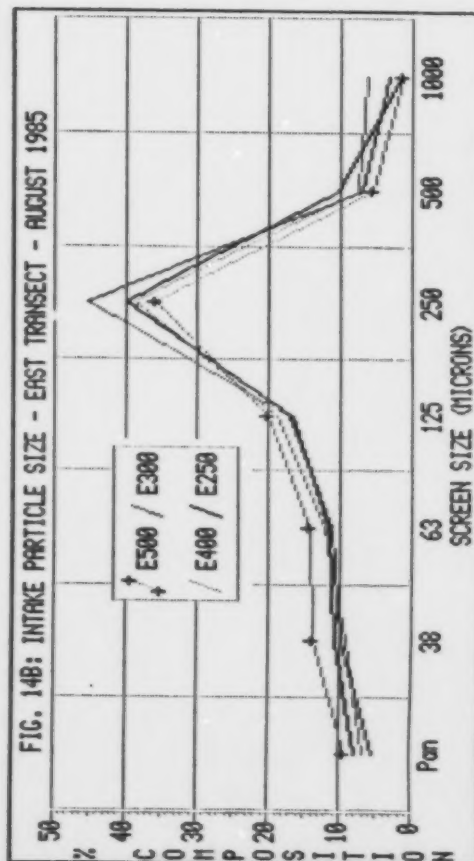
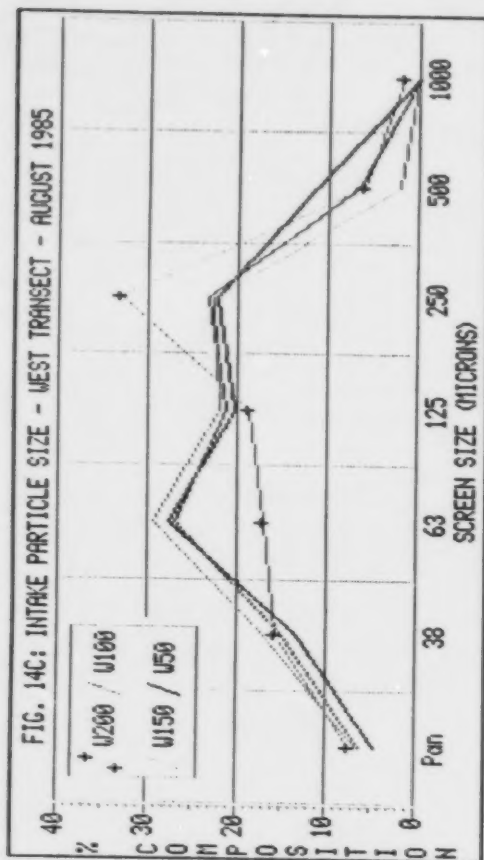
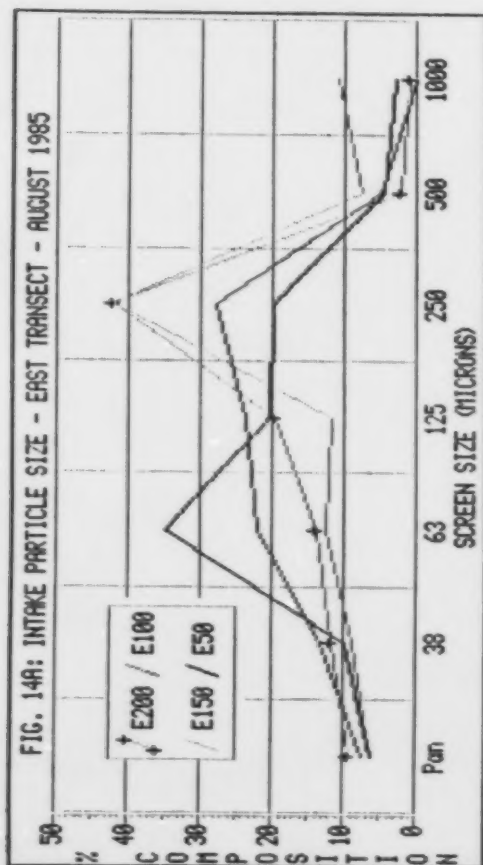
Samples collected from the west transect in September (Figure 15) were generally coarse-grained, as particles retained on the 250 micron screen were most abundant. The sample collected from 50 m west of the excavation (which had the largest total sediment accumulation in September samples) was the most coarse-grained of these samples. Samples collected from the east transect in September displayed a more varied set of particle size distributions (Figure 16). Particle size distributions for sites more distant from the intake (200 to 500 m) were generally coarse-grained and similar to the west transect sites. However, samples taken near the intake (50 to 150 m) had a relatively broad range of particle sizes, with 63, 125 and 250 micron fractions contributing about equally to the sample.

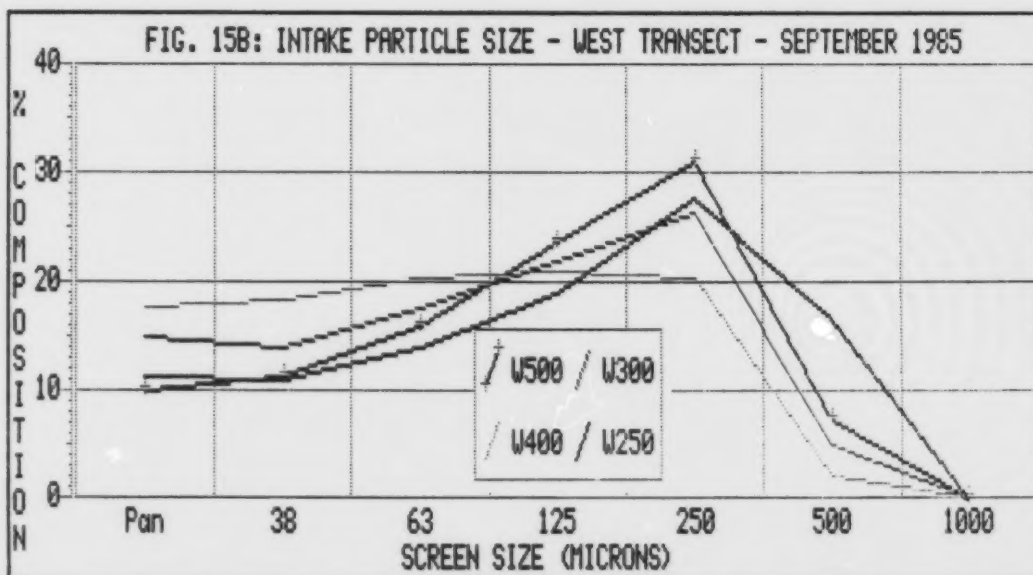
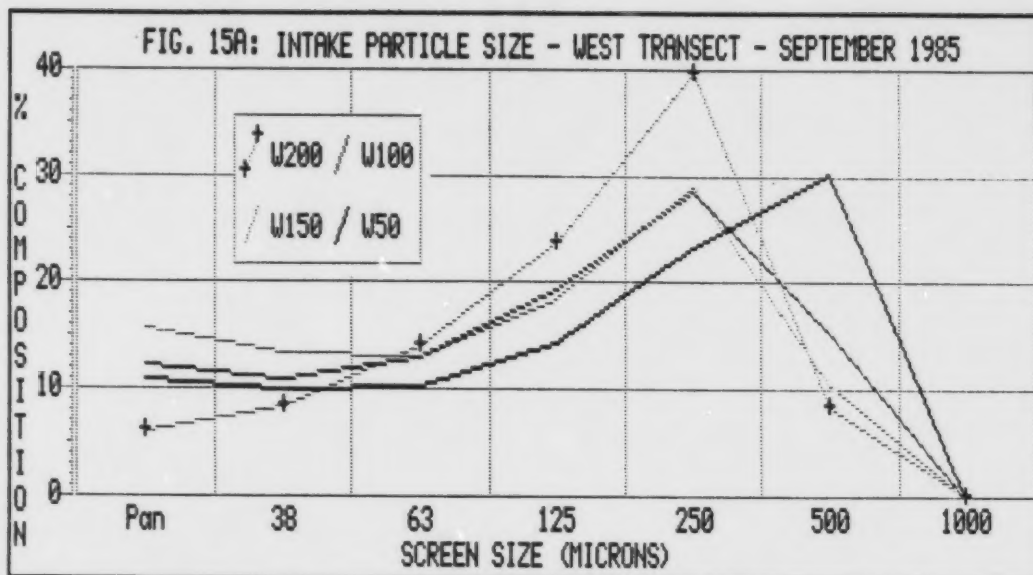
In summary, the sediment deposition data indicated that during the early phase of intake excavation (June), substantial amounts of sediment were deposited only

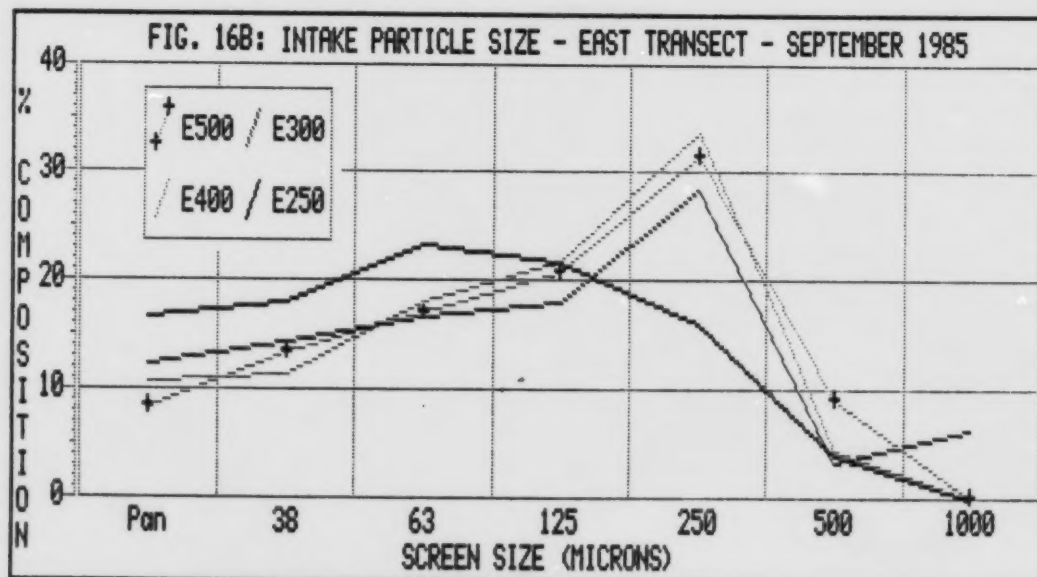
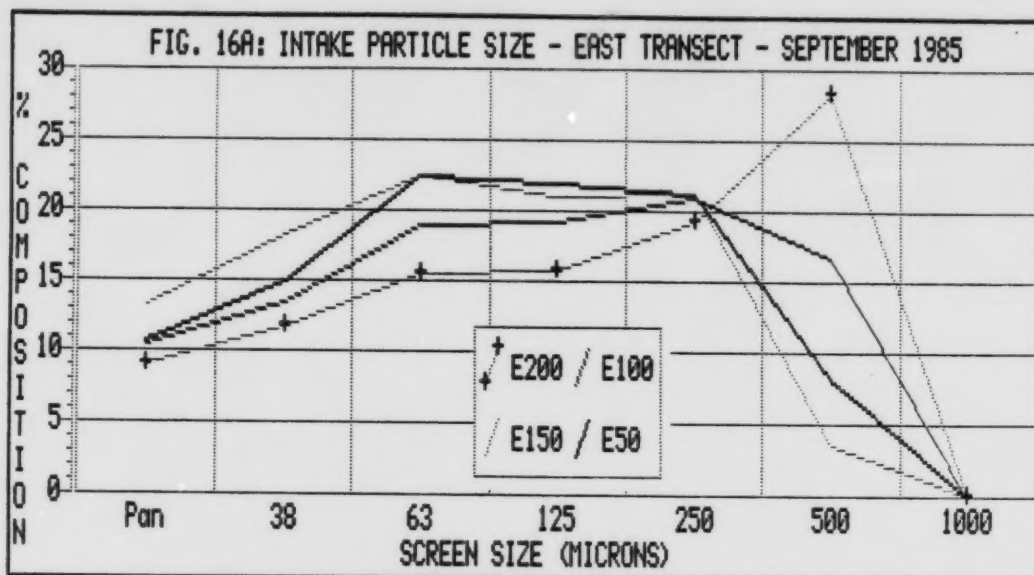












in the immediate vicinity (50 to 100 m) of the excavation. During the main phase of excavation (July) as well as during the initial period of sediment redeposition (August and September) peak deposition again occurred in the immediate intake vicinity. However, secondary peaks in deposition were noted about 200 to 250 m on either side of the excavation. Simulation studies have suggested that total sediment deposition would decline exponentially with distance from the excavation site (OH D&D Division Report 84306). However, these simulations assumed a consistent loss of dredged sediment as the material was lifted from the excavation.

Deposition patterns computed for fine particles released near the water surface were expected to peak as far as 400 m from the excavation (Figure 9 of that report). Thus, the secondary deposition peaks noted in the present data suggest that loss of dredged material from the clamshell bucket may have been greatest when the bucket was raised from the water surface. Personal observations indicated that there was a substantial loss of highly turbid water as the bucket was raised from the surface.

Present data also suggest that during August and September, somewhat larger samples were obtained to the east of the excavation, an observation which does not correlate well with observed current data. During the August sampling period, currents flowed predominantly toward the west, while during September, alternate current runs to the east and west were observed (D&D Report 87554).

Initial results (in June) indicated that sediments originating from the excavation were low in organic content and rather coarse-grained. The organic content data for subsequent months were supportive of the total deposition data, as the lowest organic contents occurred near the excavation, and generally lower values to the east suggested an eastward movement of excavated material. Particle size data were considerably more complex. Initial results (June) appeared to assist in identification of the excavated sediments, which were coarse-grained and low in organic content. The 'natural' sediments (collected from the most distant sites) at this time were fine-grained and high in organic content, suggesting a substantial contribution from settling plankton or detritus ('littoral drift'). In August and September, there was a general shift in the particle size distribution towards more coarse-grained sediments, and there was no clear correlation between particle size and sample location. Presumably, increased currents or wave action resulted in resuspension of larger particles from both the excavated and 'natural' sediments. The general increase in organic content observed in September samples may be indicative of offshore movement of organic detritus, possibly detached Cladophora filaments.

4.5.2 Dump Site Sediment Samples:

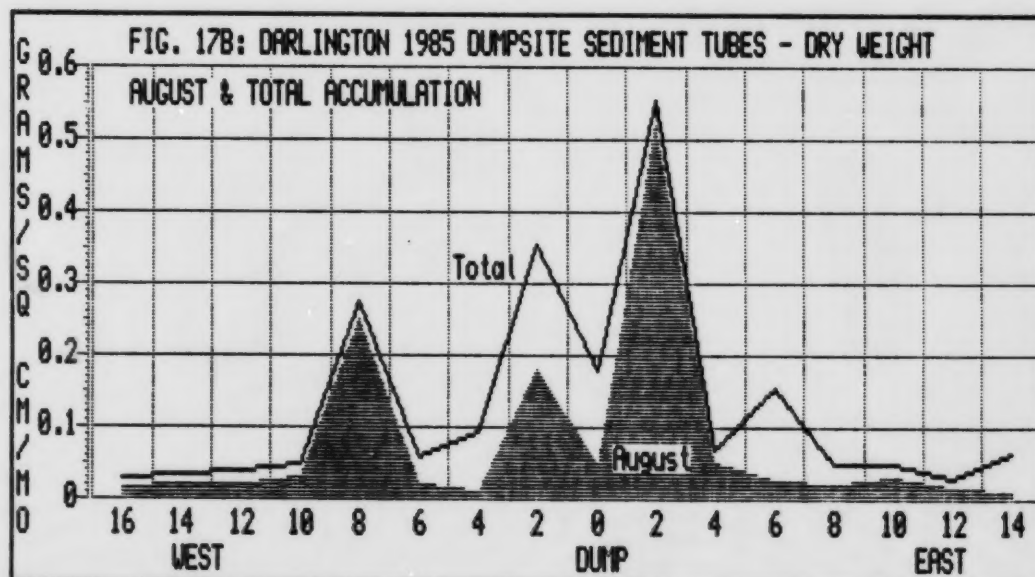
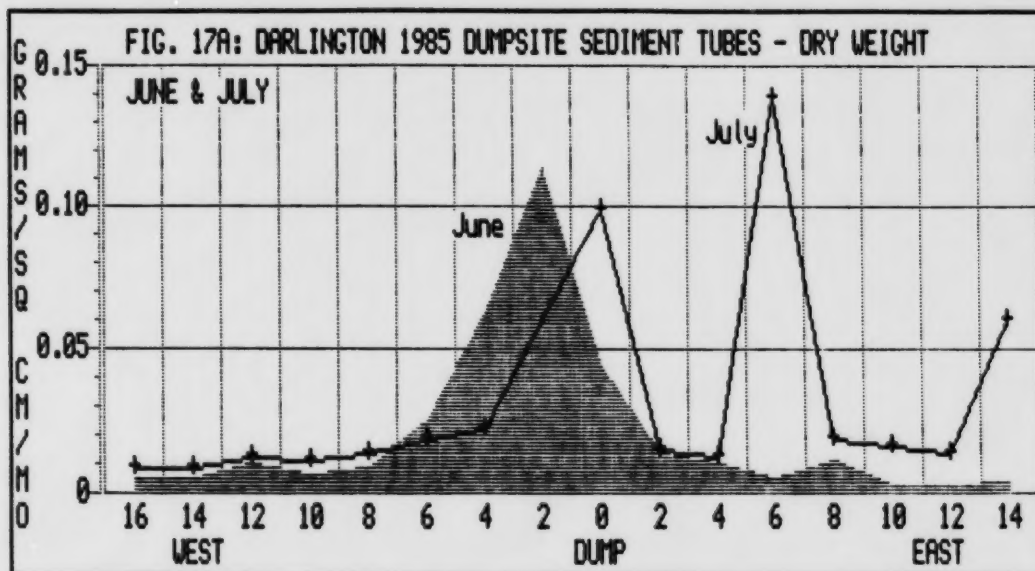
Sediment accumulation data for the dump site sampling locations over the June to August period are shown in Figure 17. In this figure, distances shown along the east and west transects are in hundreds of meters, ranging from 1600 m west to 1400 m east. In the initial set of samples (Figure 17A; June), highest deposition ($0.114 \text{ g/cm}^2/\text{month}$) occurred at the site 200 m west of the dump site. Beyond 600 m west and 200 m east of the dump site, deposition was minimal ($<0.01 \text{ g/cm}^2/\text{month}$). In July, three deposition peaks, ranging from 0.06 to 0.138

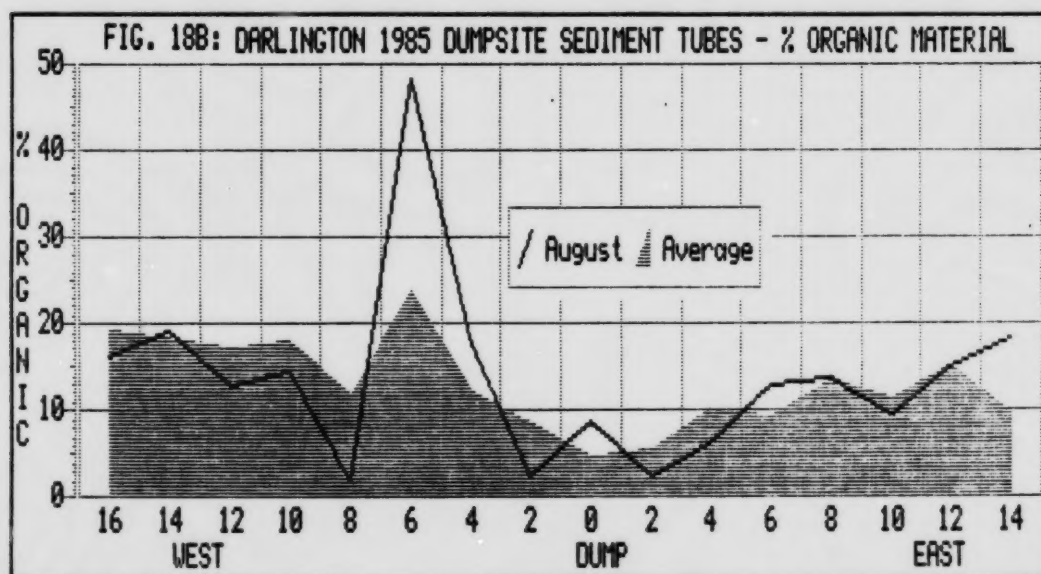
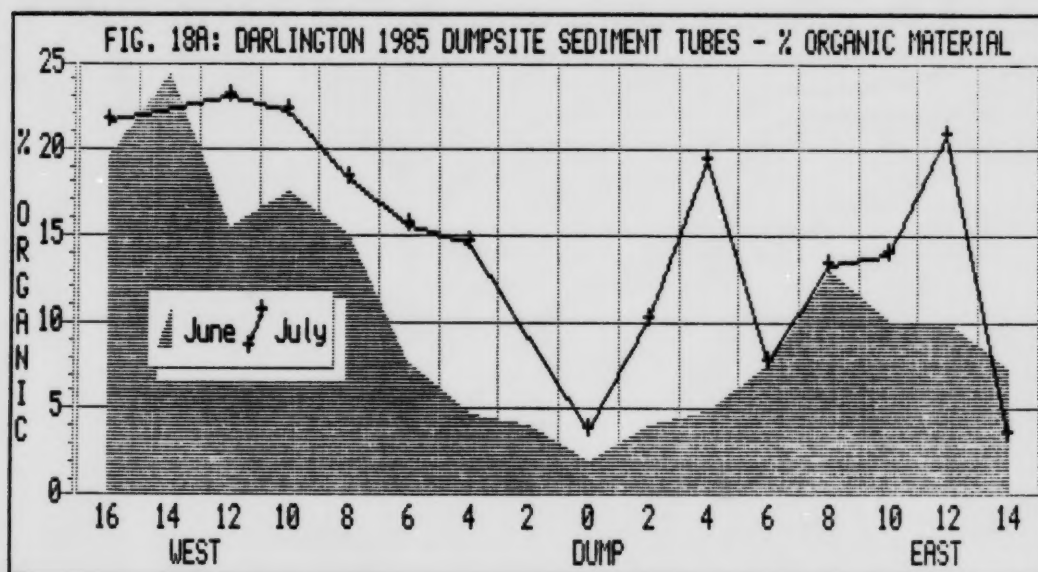
g/cm²/month, were present at the dump site centre, 600 m east and 1400 m east. Sediment deposition in August (Figure 17B) also showed three peaks. The first was 800 m west of the dump site (0.25 g/cm²/month), the second (0.182 g/cm²/month) was 200 m west, and the largest peak (0.525 g/cm²/month) was at 200 m east of the dump site. Deposition during August at sites beyond 1000 m west and 600 m east was quite low (<0.03 g/cm²/month). This, combined with the depth at the dump site area (approximately 24 m) suggests that August data reflect primary deposition rather than resuspension of dumped sediments. Although the blasting associated with excavation was completed in July, dredging equipment remained on the intake site until August.

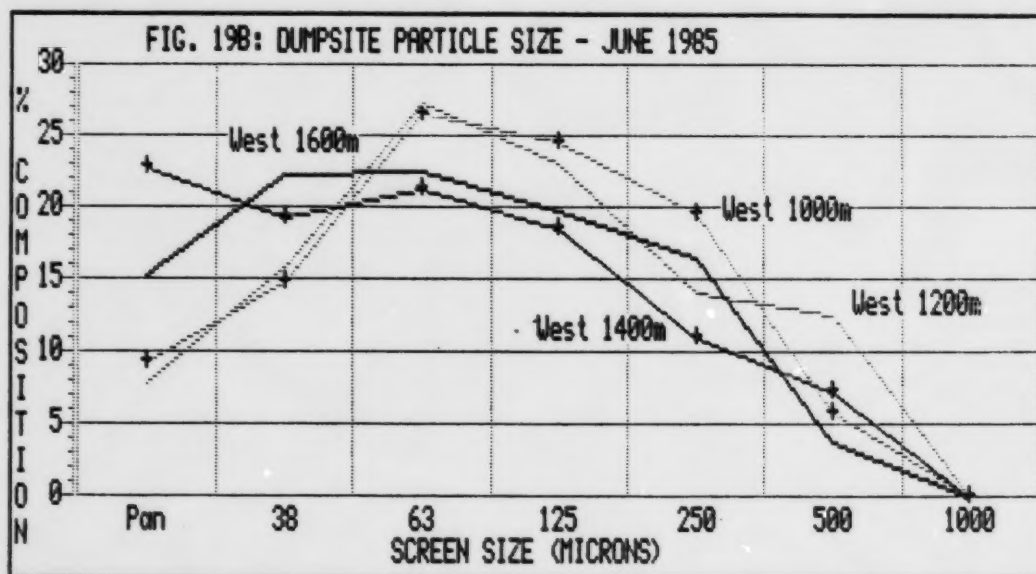
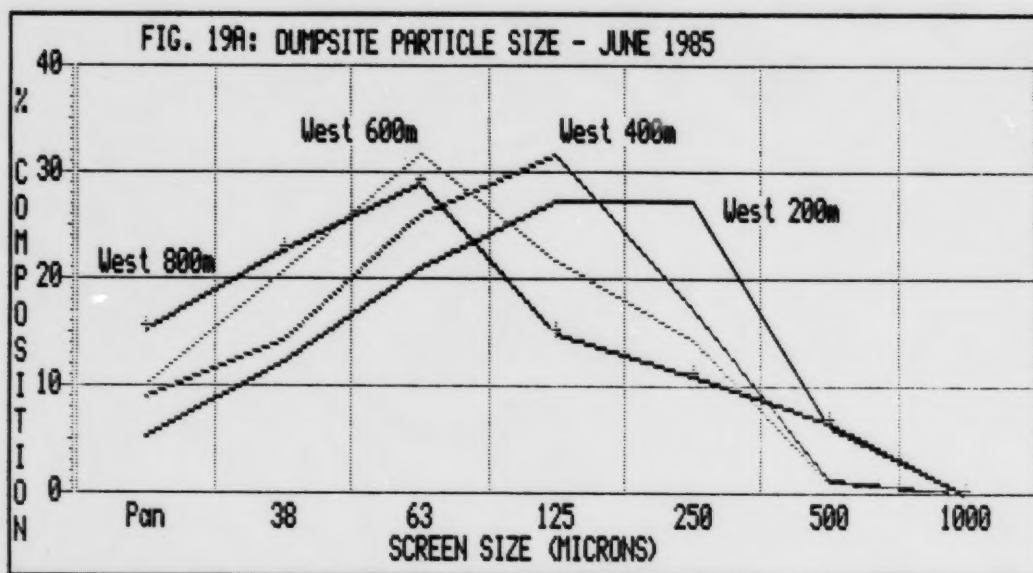
Organic content data for the dump site samples are listed in Appendix 8. A plot of the June data (Figure 18A) indicates that the lowest organic content (<5%) was associated with samples collected from the dump site vicinity (from 400 m west to 400 m east). Sites beyond 800 m west of the dump site had the highest organic content, ranging from 15 to 24%. Organic contents were generally higher in July (Figure 18A). Low organic contents in the July samples were again associated with sites of high total sediment deposition, at the dump site centre, 600 m east and 1400 m east. In August, organic content was generally below average (Figure 18B). The only exception was the site 600 m west of the dump site, where an unusually high value (48% organic material) was observed. Total deposition at this site was quite low (0.020 g/cm²/month). During August, the lowest organic contents were once again associated with peaks in total deposition (800 m west, 200 m west, 200 m east).

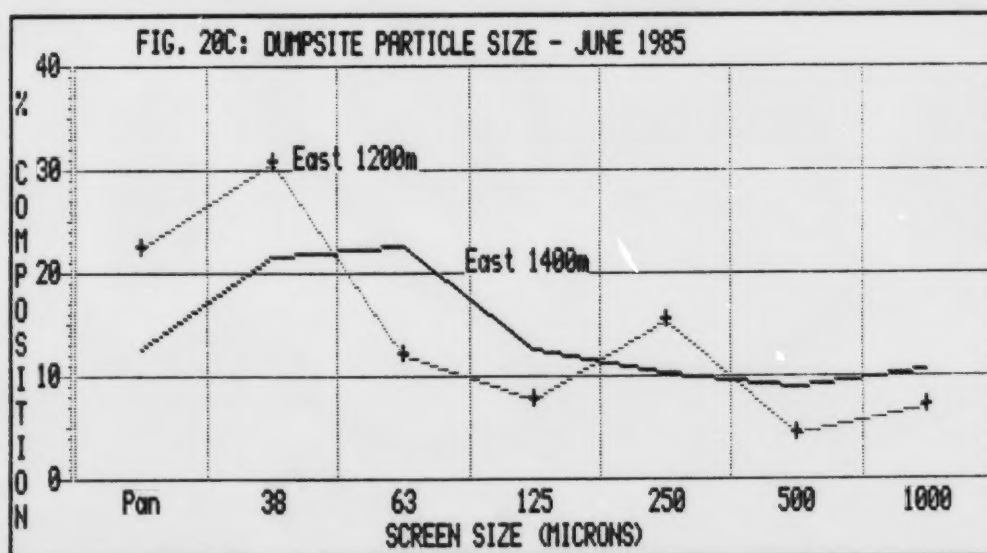
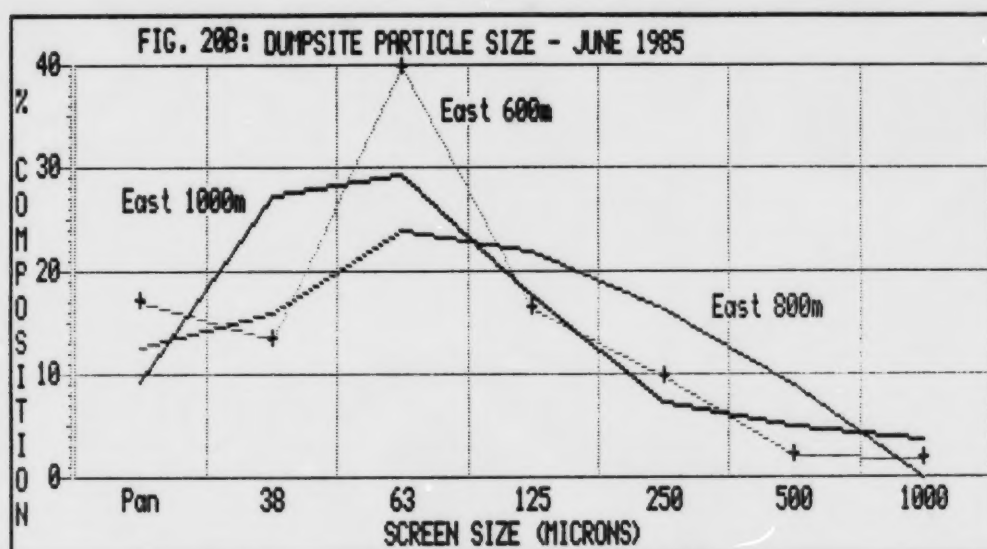
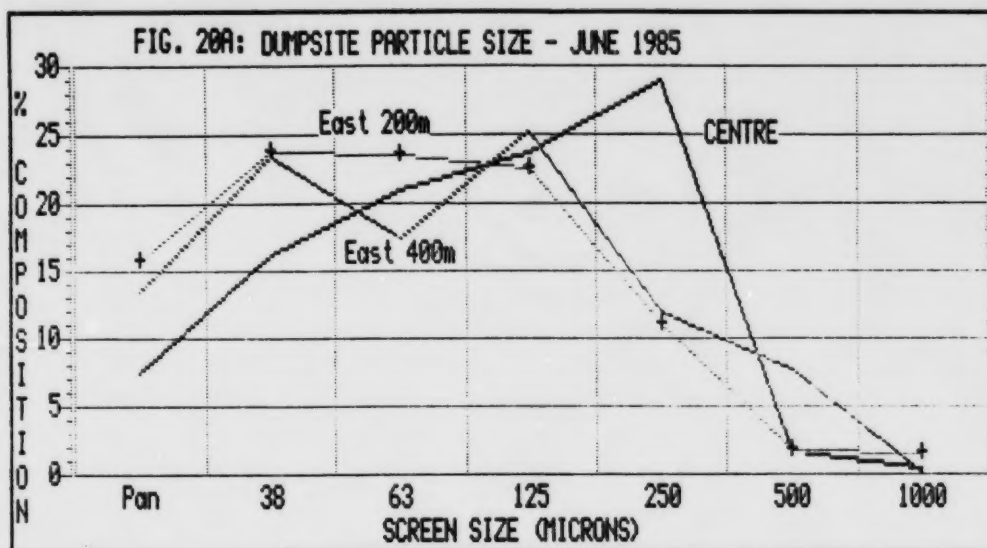
The particle size data for the dump site sediment samples are listed in Appendix 10. In June, most material was deposited near the dump site, especially to the west (at 200 and 400 m). Particle size data for the west transect show a clear gradation (from coarse to fine material) as distance increased to the west (Figure 19). Data for the eastern transect are similar, although the only really coarse-grained sample from this transect is the 'dump site centre' sample (Figure 20).

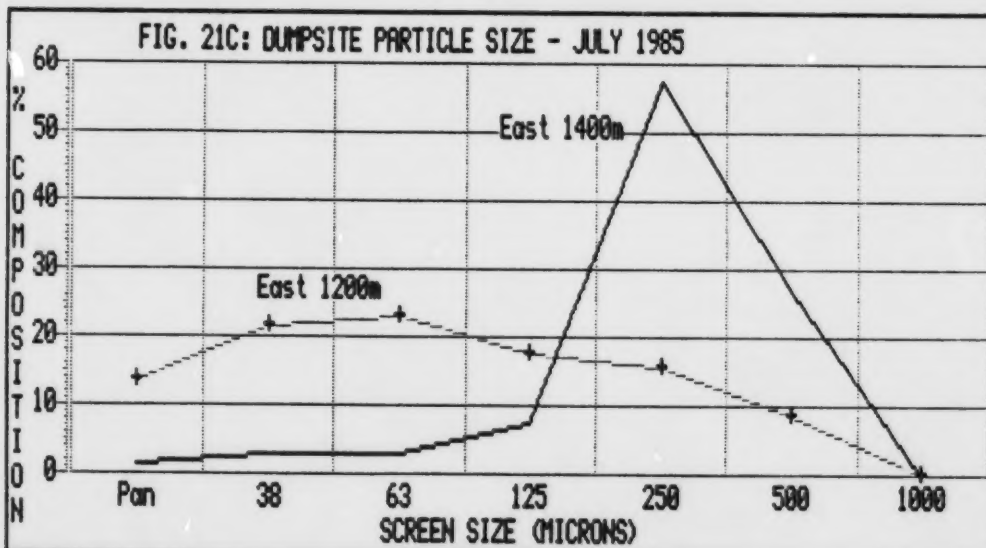
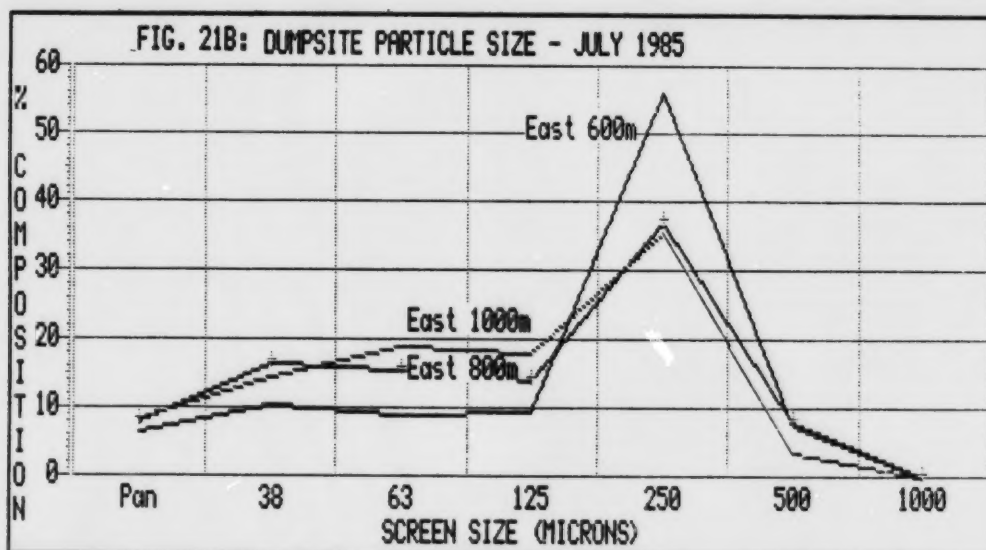
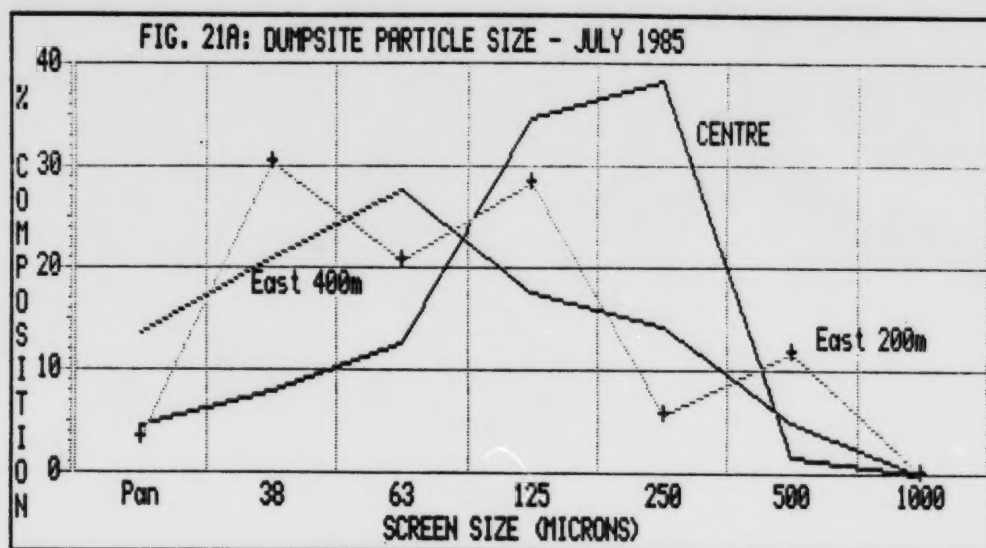
In July, deposition peaks occurred at the dump site centre, 600 m east and 1400 m east (Figure 21). Sediments collected at these locations were coarse-grained, with the 250 micron fraction predominating. The samples from the 600 m and 1400 m east sites were unusual, as they were dominated by particles of a single size (>55% from the 250 micron screen). As these sites were considerable distances from the dump site, the presence of substantial deposits of unusually well sorted sediments suggests that very strong easterly currents were present when these materials were discharged at the dump site. The alternative scenario (that the materials were discharged to the east of the dump site) would likely result in a broader range of particle sizes in the sediment samples. The locations downstream from the 600 m east site (800 and 1000 m east, assuming an easterly current) also had a high percentage (35%) of 250 micron particles, although total accumulations were quite low (<0.015 g/cm²/month) at these sites. As indicated in the discussion of intake sediment samples, currents were observed in both westerly and easterly directions during the July sampling period. Easterly currents occurred over the July 7-17 period, but were generally less than 10 cm/s. Stronger westerly currents (up to 20 cm/s) were observed at the beginning and end of the July sampling period (D&D Report 87554). However, as the current









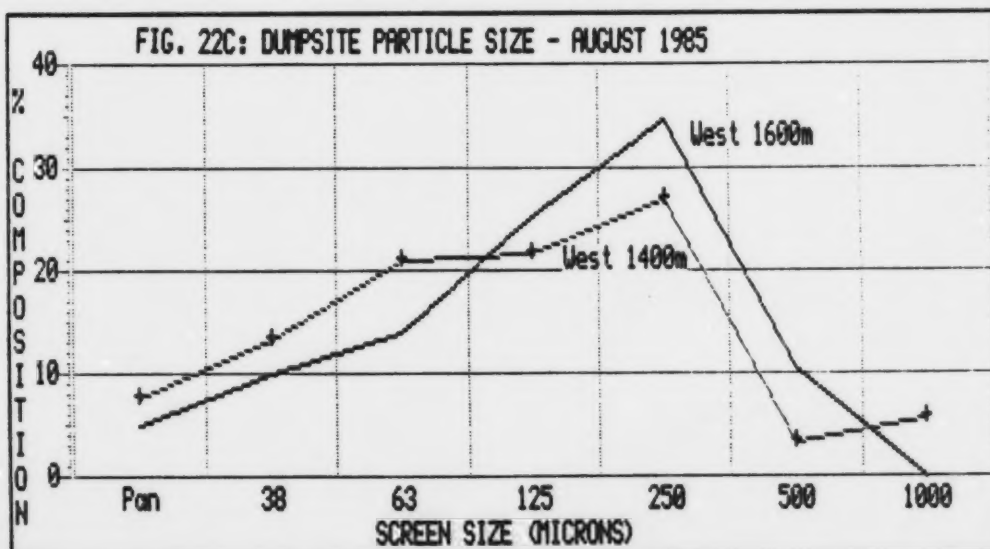
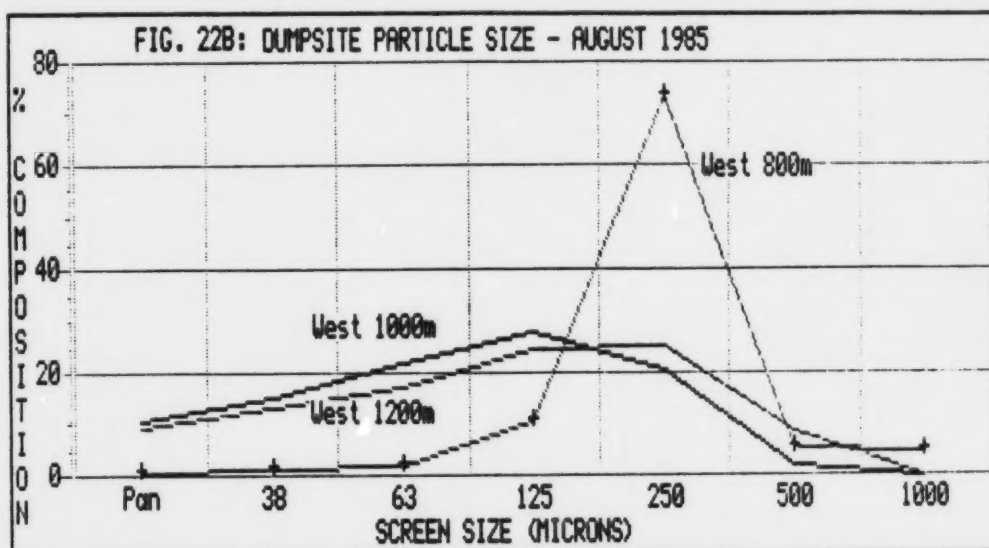
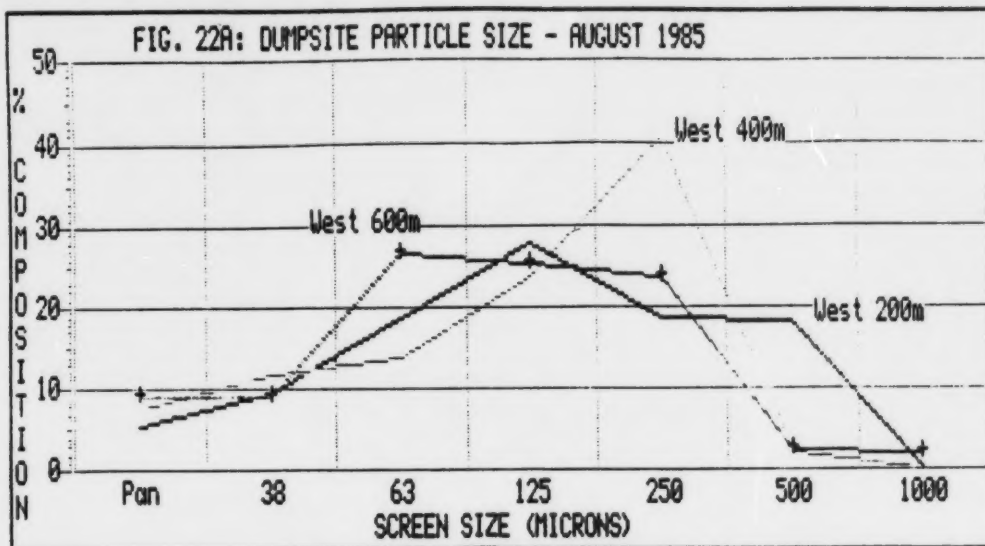


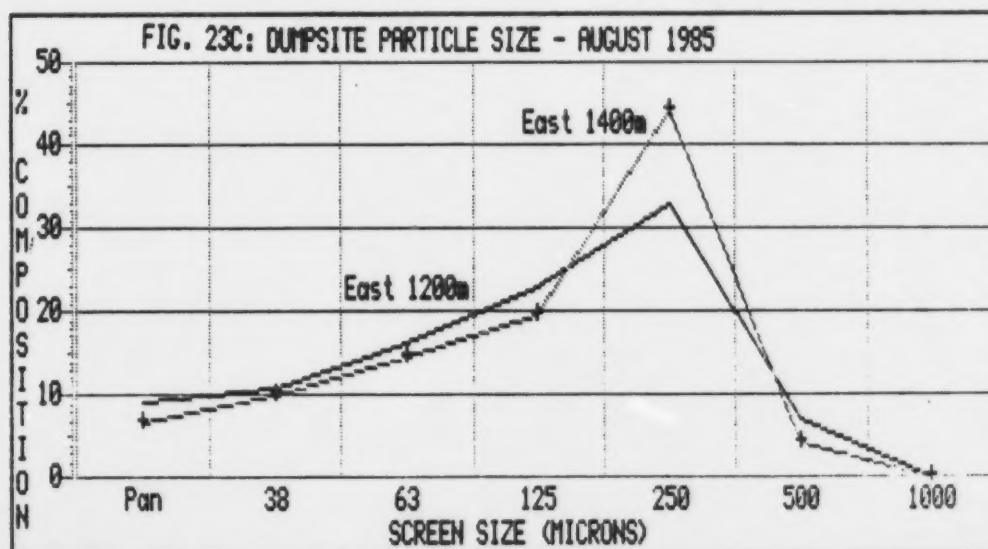
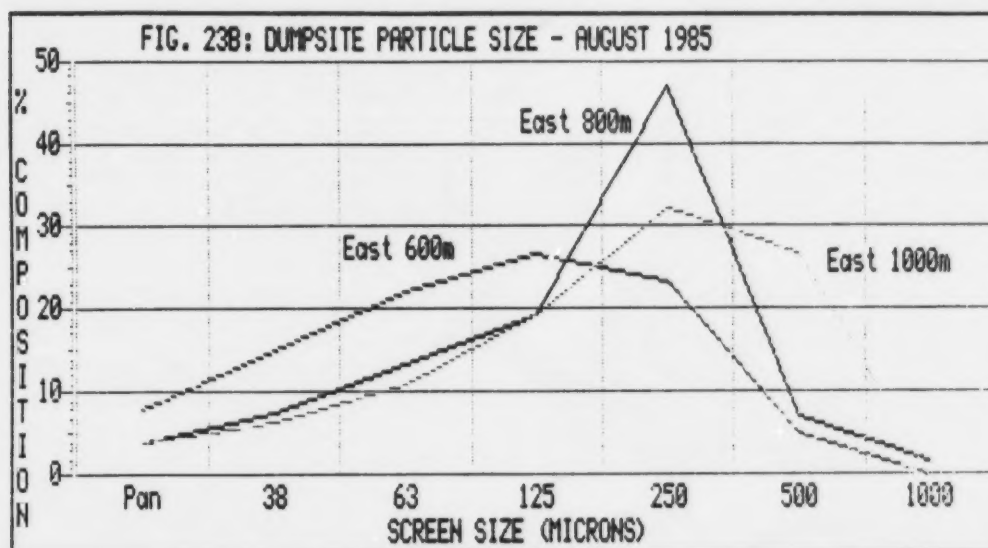
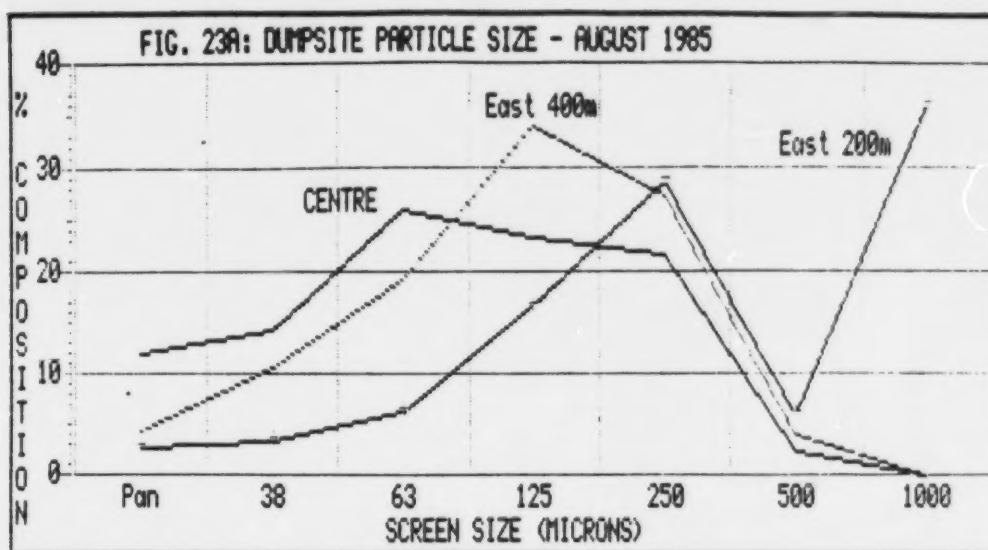
measurements were taken inshore of the dump site, at a shallower depth, results may have differed somewhat from actual currents at the dump site location.

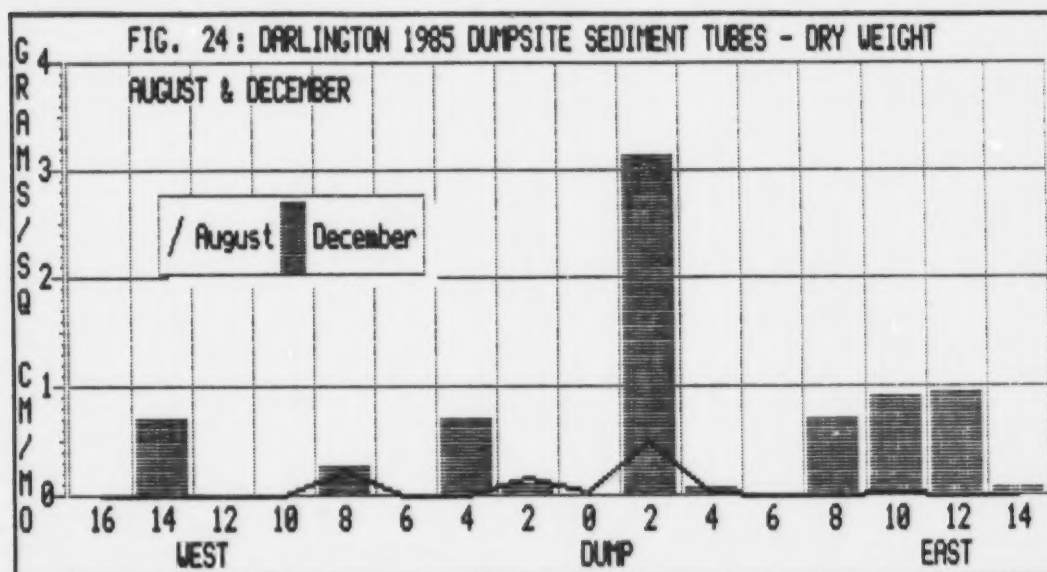
August samples were characterized by substantial accumulations near the east and west margins of the dump site and at the 800 m west site. The west 200 m site displayed a broad range of particle sizes (63 to 500 micron fractions), suggesting that materials had been discharged in close proximity to the sampler (Figure 22A). In contrast, the sample from the 800 m west site (Figure 22B) was coarse-grained and extremely well sorted (75% retained on the 250 micron screen). Currents during the August sampling period were predominantly towards the west, and reached velocities of 20 cm/s (D&D Report 87554). Samples from other west transect sites showed a variety of particle size distributions, but all were small samples. The east 200 m sample (Figure 23A) was very large (0.525 g/cm²/month), coarse and not well sorted (peaks on 250 and 1000 micron screens). Again, this sample is suggestive of material being discharged nearby. Other samples from the vicinity of the dump site (centre, east 400 m, east 600 m) were moderately fine grained and not well sorted (they contained a variety of particle sizes). Samples from the more distant sites (800 m to 1400 m east) were more well sorted, but contained only small amounts of material. Again, rather coarse particles (250 micron screen) predominated in these samples.

A substantial number of dump site sediment samples were not collected until December (Appendix 6). At that time, a complete set of east transect samples and samples from 4 west transect sites were collected. Sediment accumulations varied from 0.051 g/cm²/month to 3.163 g/cm²/month (Figure 24). The organic content of these samples was quite low (4.4% average), and ranged from 18.2 to 0.7%. The high level of deposition at the site 200 m east of the dump site (this site also had the highest deposition in the August sampling period), suggests that dumped sediments were being resuspended by fall storms or currents, even at the 24 m depth. Both winds and currents recorded over the October to December period substantially exceeded those recorded over the June to September period (D&D Report 87554).

In summary, the sediment tube samples clearly showed the influence from disposal of excavated material at the dump site. Peak deposition in June occurred immediately west (200 m) of the dump site, while in July, three deposition peaks were present (at the dump site centre, 600 m east and 1400 m east). In August, deposition peaks occurred immediately east and west of the dump site (200 m) and at the location 800 m west of the dump site. The organic content data from the dump site were similar to the intake results, as the lowest percentage of organic material consistently occurred at the sites of greatest deposition. Areas of peak deposition located near the dump site (from 200 m west to 200 m east) were characterized by a wide range of sediment particle sizes, suggesting that excavated materials had been discharged nearby. In contrast, samples from far-field areas of deposition (800 m west, 600 m east, 1400 m east) were coarse-grained and extremely well sorted, suggesting that the material had been discharged at the dump site during periods of rapid longshore currents. The far-field deposition pattern predicted for fine particles discharged at the dump site indicated that peak deposition would occur about 1000 m downstream from the source (D&D Report 84306), assuming an average lake current. Thus, present results are in general agreement with these predictions. The well sorted nature







of these far-field deposits suggests that they did not originate from Figure 22 material inadvertently discharged outside the designated dump site. The depth of sediment predicted to occur in the far-field deposition areas was minimal (0.64 mm; Ontario Hydro D&D Division Report 84306). While sediment depth was not recorded in the present study, the amounts of material observed suggest a depth of deposition somewhat greater than predicted. For example, deposition at the 800 m west site in August approximated 0.25 g/cm². As this material would be equivalent to a moderately fine sand (most retained on 250 micron screen), the depth would probably be several millimeters.

5.0 SUMMARY

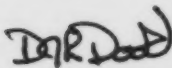
1. Juvenile and adult fish were sampled in 64 gill net sets over the May to December period, yielding a total catch of 8,659 fish. Alewife numerically dominated the catch (92.3%), followed by round whitefish (2.26%), lake trout (1.22%), white sucker (0.83%) and brown trout (0.57%). The rainbow smelt catch (46 fish = 0.53%) was much lower than in 1984 (853 fish = 7.6%).
2. Peak alewife catches were taken in late July and mid-October. Few alewife were taken in early May or after October 16. Round whitefish catches were low until mid-October, increased through November, then rose sharply during the December spawning period. Catches of salmonids (lake trout, brown trout, rainbow trout and Pacific salmon) were highest in October and November.
3. The average alewife catch at the offshore end of the diffuser (location 'D', 45.7/net) was significantly lower than at all other sites (from 135 to 164/net). There was no significant difference in catches of surface nets (133/net) and bottom nets (119/net). Round whitefish were taken almost exclusively in bottom nets. Analysis of the October to December data (when abundance was highest) indicated that the difference in fall round whitefish catch (5.5/net in 1984 vs 11.1/net in 1985) was not significant, but the catch at the inshore end of the diffuser (site 'A', 16.7/net) was significantly greater than that at the east reference area (site 'H', 3.3/net). Catches at the west reference area (site 'F', 9.8/net) and the offshore end of the diffuser (site 'D', 3.4/net) were not significantly different from the high or low catches. There were no significant locational differences in lake trout or brown trout catches. However, lake trout catches in bottom nets were approximately double the surface net catches, a significant difference. Brown trout surface catches were about double the bottom catches, also a statistically significant difference.
4. Over the April 17 to May 23 period, a total of 219 paired net tows were made to collect round whitefish larvae. Approximately equal effort was made to sample the intake and diffuser areas at depth contours from 5 to 15m, with tows being made at the surface, mid-depth and bottom. Eight larvae were collected between April 17 and April 26. Five were in bottom tows, at depths of 5, 7 (2 larvae), 10 and 15 m. One was collected in a mid-depth tow (5m contour) and two were in surface tows (at 10 and 12 m).

Consideration of these results and past catches in the Pickering area (OHRD Report 87-181-K), suggests that round whitefish larvae are vulnerable to our sampling gear (tow nets, benthic sled) for only a brief period (April 15 - 30 in most years). Hence, our sampling effort should be concentrated in this period. Earlier sampling may be required once Darlington becomes operational.

5. Blasting associated with construction of the Darlington CCW intake resulted in a limited local kill of alewife. Mortality was observed to a distance of about 200 meters, with a total kill occurring within 50 to 75 m of the blasts. The estimated average kill of alewife for the 6 blasts monitored was less than 1000 fish/blast. Lift net and diver observations indicated that almost all fish killed rose to the surface shortly after the blasts. Other species were much less susceptible to blasting. A lake trout stunned by a blast (10 m distant) appeared to recover and swim off. Cage tests indicated that substantial adverse effects on yellow perch and rock bass were restricted to the immediate blast area (approximately 25 meters). Rock bass eggs showed no adverse effects when exposed to a blast at distances from 25 meters to 1000 m.
6. Sediment deposition data were collected from sediment tubes placed east and west of the intake excavation, at distances from 50 to 500 m. Reasonably complete data were obtained during the period of excavation (June - August) and the initial period of sediment redeposition (August - September). Peak sediment deposition occurred in the immediate vicinity of the excavation (50 to 100 m), and secondary peaks in deposition were noted about 200 to 250 m on either side of the excavation. Sediments originating from the excavation were low in organic content and rather coarse-grained. A general increase in both total sediment accumulation and organic content from August to September suggests that higher current speeds increased the movement of 'natural' sediments as well as redistributing the sediments from the intake excavation. By November, the large sediment movements associated with fall storms had obliterated the deposition patterns created during intake excavation.
7. Deposition of excavated materials at the offshore dump site was monitored by sediment tubes set (at 200 m intervals) at distances up to 1400 m east and 1600 m west of the dump site. Total deposition over the June to August period was highest at the sites 200 m east and west of the dump site, with secondary deposition peaks occurring at 800 m west, 600 m east, and 1400 m east. As with the intake samples, the lowest organic contents occurred at the sites of greatest deposition. A broad range of particle sizes was observed in the large samples obtained near the dump site, indicative of nearby discharge. In contrast, sediments at the far-field areas of peak deposition were coarse-grained and unusually well sorted (most retained

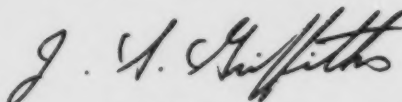
on 250 micron sieve). It is suggested that these samples resulted from discharge of material within the dump site during periods of substantial longshore currents. In previous simulation studies, peak deposition was predicted to occur about 1000 m downstream from the dump site with average lake currents.

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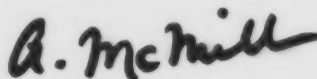
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APPENDIX 1

DARLINGTON GILLNET CATCH
MAY 15 - DECEMBER 11, 1985

APPENDIX 1A
DARLINGTON GILLNET CATCH - MAY 15, 1985
(BOTTOM NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	12	8	29	18	67	16.75
smelt	2	8	0	6	16	4
round whitefish	0	0	0	1	1	0.25
lake whitefish	0	0	0	0	0	0
lake trout	1	1	3	3	8	2
brown trout	0	0	1	0	1	0.25
rainbow trout	0	0	0	0	0	0
coho salmon	0	0	0	0	0	0
chinook salmon	0	0	0	0	0	0
white sucker	0	1	2	0	3	0.75
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	1	0	0	0	1	0.25
yellow perch	0	0	0	0	0	0
white perch	0	0	0	1	1	0.25
white bass	0	0	2	0	2	0.5
gizzard shad	0	0	0	0	0	0
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
Site Totals	16	18	37	29	100	25
					Session Total	

APPENDIX 1B
DARLINGTON GILLNET CATCH - MAY 28, 1985
(BOTTOM NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	127	39	87	256	509	127.25
smelt	4	4	0	4	12	3
round whitefish	1	0	0	2	3	0.75
lake whitefish	0	0	0	0	0	0
lake trout	2	0	0	2	4	1
brown trout	0	0	0	0	0	0
rainbow trout	0	0	0	0	0	0
coho salmon	0	0	0	0	0	0
chinook salmon	0	0	0	0	0	0
white sucker	4	4	1	4	13	3.25
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	0	0	0	0	0	0
yellow perch	0	0	0	0	0	0
white perch	0	0	0	0	0	0
white bass	0	0	0	0	0	0
gizzard shad	0	0	0	1	1	0.25
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	1	1	0.25
Site Totals	138	47	88	270	543	135.75
					Session Total	

APPENDIX 1 C
DARLINGTON GILLNET CATCH - JULY 11, 1985
(BOTTOM NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	100	2	20	147	269	67.25
smelt	1	0	0	0	1	0.25
round whitefish	0	0	0	2	2	0.5
lake whitefish	0	0	0	0	0	0
lake trout	2	1	0	2	5	1.25
brown trout	0	0	0	0	0	0
rainbow trout	0	0	1	0	1	0.25
coho salmon	0	0	0	0	0	0
chinook salmon	0	0	0	0	0	0
white sucker	0	0	0	4	4	1
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	0	0	0	0	0	0
yellow perch	0	0	0	0	0	0
white perch	0	0	0	0	0	0
white bass	0	0	0	0	0	0
gizzard shad	0	0	0	0	0	0
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
Site Totals	103	3	21	155	282	70.5
					Session Total	

APPENDIX 1 D
DARLINGTON GILLNET CATCH - JULY 31, 1985
(BOTTOM NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	485	141	1365	484	2475	618.75
smelt	1	0	0	7	8	2
round whitefish	0	0	0	0	0	0
lake whitefish	0	0	0	0	0	0
lake trout	0	0	0	0	0	0
brown trout	1	0	0	0	1	0.25
rainbow trout	0	0	1	3	4	1
coho salmon	0	0	0	2	2	0.5
chinook salmon	0	0	0	0	0	0
white sucker	10	0	0	2	12	3.0
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	1	0	0	0	1	0.25
lake chub	0	2	0	1	3	0.75
yellow perch	0	0	0	0	0	0
white perch	0	0	0	1	1	0.25
white bass	0	0	0	0	0	0
gizzard shad	0	0	0	0	0	0
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
Site Totals	498	143	1368	503	2512	628
					Session Total	

APPENDIX 1 E
DARLINGTON GILLNET CATCH - OCTOBER 16, 1985
(BOTTOM NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	181	140	3	148	472	118
smelt	0	0	0	0	0	0
round whitefish	3	6	2	0	11	2.75
lake whitefish	0	0	0	0	0	0
lake trout	10	7	4	5	26	6.5
brown trout	0	1	0	2	3	0.75
rainbow trout	1	0	0	0	1	0.25
coho salmon	0	0	0	0	0	0
chinook salmon	0	0	0	0	0	0
white sucker	9	1	1	1	12	3
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	1	2	0	3	0.75
lake chub	5	1	0	2	8	2
yellow perch	0	0	1	1	2	0.5
white perch	3	0	0	0	3	0.75
white bass	0	0	0	0	0	0
gizzard shad	0	0	1	0	1	0.25
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
rock bass	4	0	1	0	5	1.25
carp	0	0	1	0	1	0.25
Site Totals	216	157	16	159	548	137
					Session Total	

APPENDIX 1 F
DARLINGTON GILLNET CATCH - OCTOBER 28, 1985
(BOTTOM NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	3	0	0	5	8	2
smelt	0	0	0	0	0	0
round whitefish	6	3	2	0	11	2.75
lake whitefish	0	0	0	0	0	0
lake trout	2	5	2	1	10	2.5
brown trout	1	1	0	0	2	0.5
rainbow trout	0	0	0	0	0	0
coho salmon	0	0	0	0	0	0
chinook salmon	0	0	0	0	0	0
white sucker	1	0	1	1	3	0.75
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	1	0	0	0	1	0.25
yellow perch	0	0	0	0	0	0
white perch	0	0	0	0	0	0
white bass	3	1	0	0	4	1
gizzard shad	4	0	0	0	4	1
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
Site Totals	21	10	5	7	43	10.75
					Session Total	

APPENDIX 1 G
DARLINGTON GILLNET CATCH - NOVEMBER 26, 1985
(BOTTOM NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	5	0	2	0	7	1.75
smelt	0	0	0	0	0	0
round whitefish	20	0	21	4	45	11.25
lake whitefish	0	0	0	0	0	0
lake trout	4	0	6	8	18	4.5
brown trout	1	0	3	0	4	1
rainbow trout	0	0	0	0	0	0
coho salmon	0	0	0	0	0	0
chinook salmon	0	0	0	0	0	0
white sucker	2	0	7	1	10	2.5
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	10	0	2	0	12	3
yellow perch	0	0	0	1	1	0.25
white perch	0	0	0	1	1	0.25
white bass	2	0	0	0	2	0.5
gizzard shad	0	0	0	0	0	0
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
					0	
Site Totals	44	0	41	15	100	25
					Session Total	

APPENDIX 1 H
DARLINGTON GILLNET CATCH - DECEMBER 11, 1985
(BOTTOM NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	0	0	0	0	0	0
smelt	0	0	0	0	0	0
round whitefish	61	8	38	3	110	27.5
lake whitefish	0	0	0	0	0	0
lake trout	0	0	0	0	0	0
brown trout	0	0	0	1	1	0.25
rainbow trout	0	0	0	0	0	0
coho salmon	0	0	0	0	0	0
chinook salmon	0	0	0	0	0	0
white sucker	2	1	4	0	7	1.75
redhorse sucker	0	0	1	0	1	0.25
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	0	0	0	0	0	0
yellow perch	0	0	0	0	0	0
white perch	0	0	0	1	1	0.25
white bass	0	0	0	0	0	0
gizzard shad	0	1	0	0	1	0.25
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
Site Totals	63	10	43	5	121	30.25
					Session Total	

APPENDIX 2

DARLINGTON GILLNET CATCH
MAY 14 - DECEMBER 11, 1985

APPENDIX 2 A
DARLINGTON GILLNET CATCH - MAY 14, 1985
(SURFACE NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	85	20	44	13	162	40.5
smelt	0	1	0	1	2	0.5
round whitefish	0	0	0	0	0	0
lake whitefish	0	0	0	0	0	0
lake trout	1	1	2	0	4	1
brown trout	5	1	0	1	7	1.75
rainbow trout	0	0	0	0	0	0
coho salmon	1	0	0	0	1	0.25
chinook salmon	1	0	0	0	1	0.25
white sucker	0	0	0	0	0	0
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	0	0	0	0	0	0
yellow perch	0	0	0	0	0	0
white perch	0	0	0	0	0	0
white bass	0	0	0	0	0	0
gizzard shad	2	2	0	0	4	1
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
Site Totals	95	25	46	15	181	45.25
					Session Total	

APPENDIX 2 B
DARLINGTON GILLNET CATCH - MAY 28, 1985
(SURFACE NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	95	48	112	408	663	165.75
smelt	0	0	2	1	3	0.75
round whitefish	0	0	0	0	0	0
lake whitefish	0	0	0	0	0	0
lake trout	0	3	1	1	5	1.25
brown trout	0	0	0	0	0	0
rainbow trout	0	0	0	0	0	0
coho salmon	0	0	1	0	1	0.25
chinook salmon	0	0	0	0	0	0
white sucker	0	0	0	0	0	0
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	0	0	0	0	0	0
yellow perch	0	0	0	0	0	0
white perch	0	0	0	0	0	0
white bass	0	0	0	0	0	0
gizzard shad	0	0	0	0	0	0
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
rock bass	0	0	0	1	1	
Site Totals	95	51	116	411	673	168.25
					Session Total	

APPENDIX 2 C
DARLINGTON GILLNET CATCH - JULY 10, 1985
(SURFACE NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	173	16	162	47	398	99.5
smelt	0	0	2	1	3	0.75
round whitefish	0	0	0	0	0	0
lake whitefish	0	0	0	0	0	0
lake trout	0	0	0	2	2	0.5
brown trout	0	0	1	0	1	0.25
rainbow trout	1	0	0	0	1	0.25
coho salmon	0	0	1	0	1	0.25
chinook salmon	0	1	0	0	1	0.25
white sucker	0	0	0	0	0	0
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	0	0	0	0	0	0
yellow perch	0	0	0	0	0	0
white perch	0	0	1	0	1	0.25
white bass	0	0	0	0	0	0
gizzard shad	0	0	0	0	0	0
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
Site Totals	174	17	167	50	408	102
					Session Total	

APPENDIX 2 D
DARLINGTON GILLNET CATCH - JULY 30, 1985
(SURFACE NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	256	279	630	65	1230	307.5
smelt	0	0	0	1	1	0.25
round whitefish	0	0	0	0	0	0
lake whitefish	0	0	0	0	0	0
lake trout	0	1	0	0	1	0.25
brown trout	1	0	1	0	2	0.5
rainbow trout	0	0	1	0	1	0.25
coho salmon	1	0	1	1	3	0.75
chinook salmon	0	0	0	0	0	0
white sucker	0	5	0	0	5	1.25
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	0	0	0	0	0	0
yellow perch	0	0	0	0	0	0
white perch	0	0	0	0	0	0
white bass	0	0	0	0	0	0
gizzard shad	0	0	0	0	0	0
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
Site Totals	258	285	633	67	1243	310.75
					Session Total	

APPENDIX 2 E
DARLINGTON GILLNET CATCH - OCTOBER 17, 1985
(SURFACE NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	1044	37	166	354	1801	450.25
smelt	0	0	0	0	0	0
round whitefish	0	0	0	0	0	0
lake whitefish	0	0	0	0	0	0
lake trout	7	3	2	3	15	3.75
brown trout	3	0	6	4	13	3.25
rainbow trout	1	0	2	0	3	0.75
coho salmon	1	0	3	1	5	1.25
chinook salmon	0	0	0	1	1	0.25
white sucker	0	0	0	0	0	0
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	0	0	0	0	0	0
yellow perch	0	0	0	0	0	0
white perch	0	0	0	0	0	0
white bass	0	0	0	0	0	0
gizzard shad	1	0	0	1	2	0.5
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
Site Totals	1057	40	179	564	1840	460
					Session Total	

APPENDIX 2 F
DARLINGTON GILLNET CATCH - OCTOBER 29, 1985
(SURFACE NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	0	0	2	1	3	0.75
smelt	0	0	0	0	0	0
round whitefish	0	0	0	0	0	0
lake whitefish	0	0	0	0	0	0
lake trout	0	1	5	0	6	1.5
brown trout	1	1	1	0	3	0.75
rainbow trout	0	0	0	0	0	0
coho salmon	1	0	1	1	3	0.75
chinook salmon	0	0	0	0	0	0
white sucker	0	0	0	0	0	0
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	0	0	0	0	0	0
yellow perch	0	0	0	0	0	0
white perch	0	0	0	0	0	0
white bass	0	0	0	0	0	0
gizzard shad	0	0	0	0	0	0
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
Site Totals	2	2	9	2	15	3.75
					Session Total	

APPENDIX 2 G
DARLINGTON GILLNET CATCH - NOVEMBER 26, 1985
(SURFACE NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	1	1	0	8	10	2.5
smelt	0	0	0	0	0	0
round whitefish	0	0	0	2	2	0.5
lake whitefish	0	0	0	0	0	0
lake trout	1	0	1	0	2	0.5
brown trout	2	2	2	1	7	1.75
rainbow trout	9	0	7	0	16	4
coho salmon	0	0	0	0	0	0
chinook salmon	0	0	0	0	0	0
white sucker	0	0	0	0	0	0
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	0	0	0	0	0	0
yellow perch	0	0	0	0	0	0
white perch	0	0	0	0	0	0
white bass	0	0	0	0	0	0
gizzard shad	0	0	0	0	0	0
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
Site Totals	13	3	10	11	37	9.25
					Session Total	

APPENDIX 2 H
DARLINGTON GILLNET CATCH - DECEMBER 11, 1985
(SURFACE NETS)

SPECIES	Site A	Site D	Site F	Site H	Total	Fish/net
alewife	0	0	0	0	0	0
smelt	0	0	0	0	0	0
round whitefish	8	2	1	0	11	2.75
lake whitefish	0	0	0	0	0	0
lake trout	0	0	0	0	0	0
brown trout	0	1	0	0	1	0.25
rainbow trout	0	0	0	0	0	0
coho salmon	0	0	1	0	1	0.25
chinook salmon	0	0	0	0	0	0
white sucker	0	0	0	0	0	0
redhorse sucker	0	0	0	0	0	0
freshwater drum	0	0	0	0	0	0
brown bullhead	0	0	0	0	0	0
lake chub	0	0	0	0	0	0
yellow perch	0	0	0	0	0	0
white perch	0	0	0	0	0	0
white bass	0	0	0	0	0	0
gizzard shad	0	0	0	0	0	0
smallmouth bass	0	0	0	0	0	0
longnose sucker	0	0	0	0	0	0
Site Totals	8	3	2	0	13	3.25
					Session Total	

APPENDIX 3

DARLINGTON 1985 LARVAL FISH CATCH DATA
APRIL 17 - MAY 23, 1985

APPENDIX 3
DARLINGTON 1985 LARVAL FISH CATCH DATA

Date	Location	Depth Cont (meters)	# Whitefish	# Sait	# Others	Date	Location	Depth Cont (meters)	# Whitefish	# Sait	# Others
Apr 17	Int/Surf	5	0	0	0	Apr 22	Disch/Surf	5	0	0	0
		7	0	0	0			7	0	0	0
		10	0	0	0			10	0	0	0
		12	0	0	0			12	0	0	0
Apr 17	Int/Mid	5	0	0	0	Apr 22	Disch/Mid	5	0	1	0
		7	0	0	0			7	0	0	0
		10	0	0	0			10	0	0	0
		12	0	0	0			12	0	0	0
Apr 17	Disch/Surf	5	0	0	0	Apr 22	Disch/Bot	5	0	0	0
		7	0	0	0			7	0	0	0
		10	0	0	0			10	0	0	0
		12	0	0	0			12	0	0	0
		15	0	0	0			15	0	0	0
Apr 17	Disch/Mid	5	1	0	0			5	0	0	0
		7	0	0	0			7	0	0	0
		10	0	0	0			10	0	0	0
		12	0	0	0			12	0	0	0
		15	0	0	0			15	0	0	0
Apr 18	Int/Surf	15	0	0	0	Apr 25	Int/Surf	5	0	0	0
Apr 18	Int/Mid	15	0	0	0			7	0	0	0
Apr 18	Disch/Surf	5	0	0	0			10	1	0	0
		7	0	0	0			12	0	0	0
		10	0	0	0			15	0	0	0
		12	1	0	0			15	0	0	0
		15	0	0	0	Apr 25	Int/Bot	5	0	0	0
Apr 22	Int/Surf	5	0	0	0			7	0	0	0
		7	0	0	0			10	0	0	0
		10	0	0	0			12	0	0	0
		12	0	0	0			15	0	0	0
		15	0	0	0	Apr 26	Disch/Surf	5	0	0	0
Apr 22	Int/Mid	5	0	0	0			7	0	0	0
		7	0	0	0			10	0	0	0
		10	0	0	0			12	0	0	0
		12	0	0	0			15	0	0	0
		15	0	0	0	Apr 26	Disch/Mid	5	0	0	0
Apr 22	Int/Bot	5	0	0	0			7	0	0	0
		7	0	0	0			10	0	0	0
		10	1	0	0			12	0	0	0
		12	0	0	0			15	0	0	0
		15	1	0	0			15	0	0	0

72mm yearling

APPENDIX 3 CONTINUED
DARLINGTON 1985 LARVAL FISH CATCH DATA

Date	Location	Depth Cont (meters)	# Whitefish	# Smelt	# Others	Date	Location	Depth Cont (meters)	# Whitefish	# Smelt	# Others
Apr 26	Disch/Bot	5 7 10 12 15	1 2 0 0 0	0 0 0 0 0	0 0 0 0 0	May 2	Int/Mid	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
Apr 29	Int/Surf	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	May 2	Int/Bot	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
Apr 29	Int/Mid	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	May 2	Disch/Surf	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
Apr 29	Int/Bot	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	May 2	Disch/Mid	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
Apr 29	Disch/Surf	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	May 2	Disch/Bot	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
Apr 29	Disch/Mid	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	May 8	Int/Surf	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
Apr 29	Disch/Bot	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	May 8	Int/Mid	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
May 2	Int/Surf	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	May 8	Int/Bot	5 7 10 12 15	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0

APPENDIX 3 CONTINUED
DARLINGTON 1985 LARVAL FISH CATCH DATA

Date	Location	Depth Cont (meters)	# Whitefish	# Smeit	# Others	Date	Location	Depth Cont (meters)	# Whitefish	# Smeit	# Others
May 8	Disch/Bot	5	0	0	0	May 16	Int/Mid	5	0	5	0 avg 4.8 mm
		7	0	0	0			7	0	1	0 5.5 mm
		10	0	0	6(eggs)			10	0	0	0
		12	0	0	1(egg)			12	0	0	0
		15	0	0	0			15	0	0	0
May 8	Disch/Burf	5	0	1	0 5 mm	May 16	Int/Bot	5	0	0	0
		7	0	0	1 white sucker 13 mm			7	0	0	0
		10	0	0	0			10	0	0	0
		12	0	0	1(egg)			12	0	0	0
		15	0	0	0			15	0	0	0
May 8	Disch/Mid	5	0	0	0	May 17	Disch/Bot	5	0	0	0
		7	0	0	2(eggs)			7	0	0	0
		10	0	0	2(eggs)			10	0	0	0
		12	0	0	0			12	0	0	0
		15	0	0	1(egg)			15	0	0	0
May 8	Disch/Bot	5	0	0	0	May 23	Int/Burf	5	0	1	0 6 mm
		7	0	0	0			7	0	0	0
		10	0	0	0			10	0	0	0
		12	0	0	1(egg)			10	0	0	0
		15	0	0	0	May 23	Int/Mid	10	0	0	6(5 eggs) 0 6mm
May 9	Int/Burf	5	0	0	0						
		7	0	0	0						
		10	0	0	0						
		12	0	0	0						
		15	0	0	0						
May 16	Disch/Burf	5	0	10	0 avg. 5 mm						
		7	0	4	0 4 mm, 6 mm						
		10	0	0	0						
		12	0	0	0						
		15	0	0	0						
May 16	Disch/Mid	5	0	7	0 5-6 mm						
		7	0	1	0 6 mm						
		10	0	0	0						
		12	0	0	0						
		15	0	0	0						
May 16	Disch/Bot	5	0	0	0						
May 16	Int/Burf	5	0	8	0 avg 5.5 mm						
		7	0	3	0 avg 5.2 mm						
		10	0	0	0						
		12	0	0	0						
		15	0	0	0						

-----Samples Lost-----

Notes:

- Surface & Mid-Depth Samples collected with paired 0.5 m tow nets
- Bottom Samples collected with benthic sled (paired 0.5 m nets)
- All samples collected over 300 m distance, parallel to shore (approximately 5 minute tow at 1.0 m/s)

APPENDIX 4

DARLINGTON 1985 BLASTING STUDIES

- FIELD OBSERVATIONS
- TESTS WITH CAGED FISH

APPENDIX 4 A

DARLINGTON 1985 BLASTING STUDIES - FIELD OBSERVATIONS

SURFACE COUNTS OF KILLED FISH

Date	Species	Approx # killed	Maximum kill radius	Total kill radius
20/06/85	alewife	1500	200 m	-----
21/06/85	alewife	500	200 m	-----
27/06/85	alewife	300	200 m	50 m
04/07/85	alewife	300	200 m	50 m
09/07/85	alewife	2000	75 m	75 m
09/07/85	alewife	1000	50 m	50 m
09/07/85	lake trout: One stunned fish rose to the surface about 10 m from the blast. The fish swam away before it could be captured.			

MIDWATER & BOTTOM COUNTS OF KILLED FISH

		Distance from blast site (meters)						
		25	50	100	150	200	250	1000
Lift Nets	7alewife	0	0	0	0	0	-	-
(Total for 5 blasts)								
Diver Observations	<10 alewife	0	0	0	0	0	-	-
(Total for 3 blasts)								

APPENDIX 4 B

DARLINGTON 1985 BLASTING STUDIES - TESTS WITH CAGED FISH

YELLOW PERCH TEST # 1: JUNE 21, 1985 - % MORTALITY

	Distance from blast site (meters)						
Distance	25	50	100	150	200	250	1000
# of fish	(5)	(6)	(9)	(10)	(8)	(8)	(8)
Effects:							
Immediate	0	0	0	0	0	0	0
24 hours	0	0	0	0	0	0	0
48 hours	0	0	11.1	0	0	12.5	0
72 hours	0	0	11.1	0	0	12.5	0
96 hours	0	0	22.2	0	12.5	12.5	0

YELLOW PERCH TEST # 2: JUNE 27, 1985 - % MORTALITY

	Distance from blast site (meters)						
Distance	25	50	100	150	200	250	1000
# of fish	(9)	(8)	(8)	(9)	(8)	(9)	(9)
Effects:							
Immediate	all stunned	0	0	0	0	0	0
24 hours	77.8	0	12.5	0	12.5	0	0
48 hours	88.8	0	12.5	0	25.0	11.1	11.1
72 hours	88.8	0	25.0	11.1	25.0	11.1	11.1
96 hours	100.0	0	37.5	22.2	62.5	22.2	11.1

APPENDIX 4 C

DARLINGTON 1985 BLASTING STUDIES - TESTS WITH CAGED FISH

ROCK BASS ADULT TEST : JULY 9, 1985 - % MORTALITY

Distance from blast site (meters)							
Distance	25	50	100	150	200	250	1000
# of fish	(10)	(10)	(7)	(10)	(10)	-	(9)
Effects:							
Immediate	all stunned	0	0	0	0	-	0
24 hours	40.0	50.0	28.6	30.0	20.0	-	50.0
48 hours	60.0	60.0	57.1	40.0	60.0	-	50.0
72 hours	60.0	90.0	71.4	90.0	70.0	-	66.7

-----Tests Terminated at 72 Hours Due to Poor Condition of Test Fish-----

ROCK BASS EGG TEST : JULY 4, 1985 - % MORTALITY

Distance from blast site (meters)							
Distance	25	50	100	150	200	250	1000
# of eggs	(25)	(25)	(25)	(25)	(25)	(25)	(25)
Effects:							
24 hours	13.6	19.0	sample	23.1	0.0	34.8	11.1
# of eggs*	(22)	(21)	lost	(13)	(4)	(23)	(18)
48 hours	50.0	35.0	-	23.1	0.0	52.4	50.0
# of eggs	(22)	(20)	-	(13)	(4)	(21)	(12)
	hatch	hatch	-	hatch		hatch	hatch
72 hours	-	-	-	-	33.3	-	-
# of eggs					(3) hatch		
% Survival at Hatch	50.0	65.0	-	76.9	66.7	47.6	50.0

* Decreasing egg numbers reflect eggs lost from incubation cages

APPENDIX 5

DARLINGTON 1985 INTAKE SEDIMENT TUBES
DRY WEIGHT

APPENDIX 5
DARLINGTON 1985 INTAKE SEDIMENT TUBES
DRY WEIGHT (Grams)

Month/Loc	Tube	DISTANCE FROM EXCAVATION (Meters)							
		50	100	150	200	250	300	400	500
June/East	A	5.691	0.779	0.145	0.160	0.167	0.202	0.130	0.116
33 days	B	10.580	0.765	0.412	0.162	0.167	0.237	0.145	0.131
	Mean	8.1405	0.772	0.2785	0.161	0.167	0.2195	0.1375	0.1235
	G/cm ² /Month	0.3651	0.0346	0.0125	0.0072	0.0075	0.0099	0.0062	0.0055
June/West	A	0.967	0.448	0.383	0.127	0.199	0.127	0.215	0.106
33 days	B	0.721	0.509	0.147	0.162	0.198	0.177	0.104	0.074
	Mean	0.844	0.4785	0.265	0.1445	0.1985	0.152	0.1595	0.090
	G/cm ² /Month	0.0379	0.0215	0.0119	0.0065	0.0089	0.0068	0.0072	0.0040
July/East	A	3.064	2.695	0.179	2.619	2.112	1.790	1.232	1.005
26 days	B	2.690	0.559	2.156	3.089	2.247	1.640	1.083	1.262
	C			2.482					
	Mean	2.877	1.627	1.6057	2.854	2.1795	1.715	1.1575	1.1335
	G/cm ² /Month	0.1638	0.0926	0.0914	0.1625	0.1241	0.0976	0.0659	0.0645
July/West	A	1.162	1.549	1.114	2.320	1.801	0.854	1.361	1.517
26 days	B	1.345	1.743	1.246	2.477	1.950	0.980	1.275	1.334
	Mean	1.2535	1.646	1.180	2.3985	1.8755	0.917	1.318	1.4255
	G/cm ² /Month	0.0714	0.0937	0.0672	0.1365	0.1068	0.0522	0.0750	0.0812
August/East	A	1.750	1.460	1.095	1.396	1.847	1.528	1.382	1.917
27 days	B	2.092	1.733	1.162	1.370	1.879	1.346		1.811
	Mean	1.921	1.5965	1.1285	1.383	1.863	1.437	1.382	1.864
	G/cm ² /Month	0.1053	0.0875	0.0619	0.0758	0.1021	0.0788	0.0758	0.1022
August/West	A	1.810	0.984	1.115	0.997	0.660	0.815	0.644	0.663
27 days	B	3.538	1.244	1.028	0.907		0.780	0.953	0.675
	Mean	2.674	1.114	1.0715	0.952	0.660	0.7975	0.7985	0.669
	G/cm ² /Month	0.1466	0.0611	0.0587	0.0522	0.0362	0.0437	0.0438	0.0367
Sept/East	A	4.028	3.297	2.556	3.232	2.685	2.626	2.566	2.727
40 days	B	3.970	3.425	2.862	3.216	2.488	2.230	2.404	2.828
	Mean	3.999	3.361	2.709	3.224	2.5865	2.428	2.485	2.7775
	G/cm ² /Month	0.1480	0.1244	0.1003	0.1193	0.0957	0.0899	0.0920	0.1028

APPENDIX 5 CONTINUED

Month/Loc	Tube	DISTANCE FROM EXCAVATION (Meters)							
		50	100	150	200	250	300	400	500
Sept/West	A	5.083	2.524	2.144	0.915	2.814	1.914	1.874	2.246
40 days	B	4.765	2.532	2.677	0.955	2.632	2.196	1.905	2.536
	Mean	4.924	2.528	2.4105	0.935	2.723	2.055	1.8895	2.391
	G/cm ² /Month	0.1823	0.0936	0.0892	0.0346	0.1008	0.0761	0.0699	0.0885
Nov/West	A	44.79	63.23	35.55	40.52	52.12	42.07	91.07	57.02
37 days	B	44.87	65.37	34.64	42.71	43.17	47.58	46.63	48.53
	Mean	44.83	64.30	35.095	41.615	47.645	44.825	68.85	52.775
	G/cm ² /Month	1.7939	2.5730	1.4043	1.6652	1.9065	1.7937	2.755	2.1118
Mar '86/East	A	641.7	46.09	40.75					31.45
155 days	B	698.7	51.79						
	Mean	670.2	48.94	40.75					31.45
	G/cm ² /Month	6.399	0.4673	0.3891					0.3003

APPENDIX 6

DARLINGTON 1985 DUMPSITE SEDIMENT
TUBES DRY WEIGHT

APPENDIX 6
DARLINGTON 1985 DUMPSITE SEDIMENT TUBES
DRY WEIGHT (Grams)

Month/Loc	Tube	DISTANCE FROM DUMPSITE (Meters)							
		Cent	200	400	600	800	1000	1200	1400
June/East	A	0.827	0.198	0.198	0.121	0.321	0.068	0.068	0.120
32 days	B	1.064	0.404	0.236	0.115	0.186	0.068	0.070	0.085
	Mean	0.9455	0.301	0.217	0.118	0.2535	0.068	0.069	0.1025
	G/cm ² /Month	0.0437	0.0139	0.0100	0.0055	0.0117	0.0032	0.0032	0.0047
July/East	A	1.520	0.265	0.238	0.362	0.187	0.369	0.257	0.947
26 days	B	1.921		0.220	4.500	0.471	0.206		1.169
	Mean	1.7205	0.265	0.229	2.431	0.329	0.2875	0.257	1.058
	G/cm ² /Month	0.0979	0.0151	0.0130	0.1384	0.0187	0.0164	0.0146	0.0602
Aug/East	A	0.864	7.759	0.848	0.585	0.510	0.675	0.286	0.249
30 days	B	1.138	13.51	1.237	0.592	0.444	0.695	0.334	0.237
	Mean	1.001	10.6345	1.0425	0.5885	0.477	0.685	0.310	0.243
	G/cm ² /Month	0.0494	0.5247	0.0514	0.0290	0.0235	0.0338	0.0153	0.0120
Sept/East	A		2.192					0.846	
38 days	B		2.084					1.147	
	Mean		2.138					0.9965	
	G/cm ² /Month		0.0833					0.0388	
Nov/East	A	17.92					9.149		
73 days	B	17.35							
	Mean	17.635					9.149		
	G/cm ² /Month	0.3576					0.1855		
Dec/East	A		140.30	7.343	5.502	96.00	18.97	10.16	7.021
102 days	B		133.20	7.850	1.575	5.73	17.33	73.38	7.174
	Mean		136.75	7.5965	3.539	50.865	18.15	41.77	7.0975
	G/cm ² /Month		3.1632	0.1102	0.0514	0.7381	0.9263	0.9662	0.1030
			64				29	64	
			days				days	days	

APPENDIX 6 CONTINUED

Month/Loc	Tube	DISTANCE FROM DUMPSITE (Meters)							
		200	400	600	800	1000	1200	1400	1600
June/West	A	2.952	1.380	0.620	0.146	0.124	0.254	0.109	0.127
32 days	B	1.976	1.304	0.484	0.264	0.153	0.202	0.121	0.196
	Mean	2.464	1.342	0.552	0.205	0.1385	0.228	0.115	0.1615
	G/cm ² /Month	0.1140	0.0621	0.0255	0.0095	0.0064	0.0106	0.0053	0.0075
July/West	A		0.423	0.377	0.240	0.230	0.245		0.150
26 days	B		0.365	0.280	0.275	0.189	0.215		0.158
	Mean		0.394	0.3285	0.2575	0.2095	0.230		0.154
	G/cm ² /Month		0.0224	0.0187	0.0147	0.0119	0.0131		0.0088
Aug/West	A	3.282	0.261	0.338	1.496	0.702	0.431	0.564	0.380
30 days	B	4.113	0.274	0.482	8.638	0.619	0.432	0.424	0.331
	Mean	3.6975	0.2675	0.410	5.067	0.6605	0.4315	0.494	0.3555
	G/cm ² /Month	0.1824	0.0132	0.0202	0.2499	0.0326	0.0213	0.0244	0.0175
Dec/West	A	7.117	9.893		30.720			58.090	
102 days	B	11.480	92.720		12.31			45.250	
	Mean	9.299	51.3065		21.515			51.670	
	G/cm ² /Month	0.1349	0.7445		0.3122			0.7498	

APPENDIX 7

DARLINGTON 1985 INTAKE
SEDIMENT TUBES PERCENTAGE ORGANIC MATERIAL

APPENDIX 7
DARLINGTON 1985 INTAKE SEDIMENT TUBES
PERCENTAGE ORGANIC MATERIAL

Month/Loc	Tube	DISTANCE FROM EXCAVATION (Meters)							
		50	100	150	200	250	300	400	500
June/East	A	3.17	6.50	13.14	15.65	12.50	15.76	14.73	15.52
	B	3.12	6.47	4.98	11.25	14.11	13.87	14.18	16.13
June/West	A	9.05	8.58	14.44	28.57	12.69	16.15	16.94	14.74
	B	15.83	9.88	13.25	56.14	12.69	14.56	15.46	15.15
July/East	A	5.69	5.93	24.31	7.30	7.33	8.00	8.01	10.41
	B	5.60	7.65	6.28	6.72	6.75	7.70	8.08	10.21
	C			6.81					
July/West	A	8.22	7.55	8.87	7.87	8.60	13.17	10.33	12.26
	B	7.43	7.03	10.69	8.88	8.01	10.25	11.94	10.73
Aug/East	A	3.31	8.39	5.96	3.43	9.25	3.43	3.15	1.66
	B	2.19	8.14	9.54	6.30	8.89	3.06		3.30
Aug/West	A	5.70	6.41	7.52	3.79	9.63	11.05	9.50	9.30
	B	4.67	7.22	8.20	4.81		11.37	7.94	8.74
Sept/East	A	6.32	7.26	7.27	6.94	7.42	7.20	9.42	8.88
	B	6.36	6.96	7.56	7.22	26.56	7.68	8.73	8.57
	C				7.40	8.89	8.13		
	D				6.68		8.24		
Sept/West	A	7.79	8.26	8.70	13.71	8.59	48.12	8.82	8.86
	B	7.97	8.32	8.13	14.14	10.84	8.28	8.85	7.84
	C		13.99			8.43	9.70		
	D		13.50			12.83	8.65		
Nov/West	A	5.46	5.34	5.96	5.89	5.84	6.00	3.54	6.58
	B	5.54	5.16	5.79	5.85	5.78	5.91	6.05	6.11
March/East	A	2.51	2.16	2.11					2.27
	B	2.65	2.51						

APPENDIX 8

DARLINGTON 1985 DUMPSITE
SEDIMENT TUBES PERCENTAGE ORGANIC MATERIAL

APPENDIX 8
DARLINGTON 1985 DUMPSITE SEDIMENT TUBES
PERCENTAGE ORGANIC MATERIAL

Month/Loc	Tube	DISTANCE FROM DUMPSITE (Meters)							
		Cent	200	400	600	800	1000	1200	1400
June/East	A	2.20	3.85	4.61	7.20	10.66	13.33	10.62	7.81
	B	1.81	4.13	4.94	7.89	15.05	6.90	9.38	6.98
July/East	A	2.99		18.40	13.53	18.52	11.37	20.68	3.42
	B	4.54	10.23	20.31	1.77	8.26	16.67		3.83
Aug/East	A	9.09	2.53	7.32	12.96	12.25	10.38	16.73	18.99
	B	8.61	2.94	5.53	12.95	15.49	8.78	13.48	17.90
Sept/East	A		11.40					16.25	
	B		9.80					15.79	
Nov/East	A	4.09					2.74		
	B	4.02							
Dec/East	A		2.29	5.73	5.74	0.78	3.56	3.48	5.16
	B		2.27	5.06	12.47	5.30	2.20	0.88	4.63

Month/Loc	Tube	DISTANCE FROM DUMPSITE (Meters)							
		200	400	600	800	1000	1200	1400	1600
June/West	A	3.59	4.40	5.97	17.24	16.10	15.00	24.24	19.51
	B	4.58	4.96	9.15	12.84	18.67	15.96	24.14	20.32
July/West	A		14.29	16.81	19.03	21.80	22.73		21.88
	B		14.65	14.50	17.76	22.54	23.21		22.79
Aug/West	A	2.97	21.63	88.14	3.42	13.51	13.35	23.86	16.34
	B	2.13	13.87	8.37	1.11	15.76	12.66	14.50	16.40
Dec/West	A	18.26	3.89		3.18			0.91	
	B	5.02	1.53		4.32			1.03	

APPENDIX 9

PARTICLE SIZE DISTRIBUTION
FOR INTAKE SEDIMENT SAMPLES - 1985

APPENDIX 9
PARTICLE SIZE DISTRIBUTION
FOR INTAKE SEDIMENT SAMPLES - 1985

Month/ Location	Tube	Percentage of Total Weight Retained on Each Screen							Wt(g)
		Pan	Screen 38	Size 63	in 125	Microns 250	500	1000	
June East 50m	A	8.56	16.34	20.03	21.26	25.83	5.66	2.32	5.691
	B	12.65	22.29	21.72	19.45	20.40	3.27	0.24	10.590
June East 100m	A	16.69	28.63	31.71	15.53	6.55	0.90	0.00	0.779
	B	19.22	30.20	29.54	13.20	6.14	1.70	0.00	0.765
June East 150m	A	21.38	15.17	33.79	19.31	6.21	4.14	0.00	0.145
	B	9.95	9.22	8.25	4.13	1.21	3.88	63.35	0.412
June East 200m	A	20.00	27.50	29.38	13.13	5.00	5.00	0.00	0.160
	B	16.67	27.78	29.01	12.96	8.02	5.56	0.00	0.162
June East 250m	A	11.38	23.35	24.55	15.57	13.77	11.38	0.00	0.167
	B	14.97	22.16	23.35	22.16	14.97	2.40	0.00	0.167
June East 300m	A	12.38	18.81	25.74	21.29	15.84	5.94	0.00	0.202
	B	13.50	21.94	26.58	15.19	13.92	8.86	0.00	0.237
June East 400m	A	20.00	26.92	24.62	13.85	8.46	6.15	0.00	0.130
	B	13.10	18.62	26.90	19.31	13.79	8.28	0.00	0.145
June East 500m	A	18.97	23.28	25.86	21.55	9.48	0.86	0.00	0.116
	B	18.32	18.32	26.72	16.79	16.79	3.05	0.00	0.131
June West 50m	A	8.17	21.92	36.81	19.75	10.13	1.24	1.96	0.967
	B	9.85	23.99	30.51	16.09	11.10	0.42	8.04	0.721
June West 100m	A	5.58	24.78	37.50	22.10	9.15	0.45	0.45	0.448
	B	4.72	18.66	37.13	21.41	15.52	1.57	0.98	0.509
June West 150m	A	3.92	17.75	27.68	15.67	25.59	5.48	3.92	0.383
	B	19.05	28.57	24.49	17.01	10.20	0.68	0.00	0.147
June West 200m	A	11.02	16.54	29.13	30.71	5.51	7.09	0.00	0.127
	B	20.37	21.60	21.60	21.60	12.96	1.85	0.00	0.162
June West 250m	A	11.06	16.08	23.62	26.13	22.11	1.01	0.00	0.199
	B	9.60	18.69	27.78	22.73	20.20	1.01	0.00	0.198
June West 300m	A	4.72	19.69	31.50	25.98	16.54	1.57	0.00	0.127
	B	20.34	21.47	22.03	17.51	14.69	3.95	0.00	0.177
June West 400m	A	5.58	13.95	13.95	11.16	15.81	15.35	24.19	0.215
	B	16.35	25.00	28.85	19.23	7.69	2.88	0.00	0.104

APPENDIX 9 CONTINUED
PARTICLE SIZE DISTRIBUTION
FOR INTAKE SEDIMENT SAMPLES - 1985

Month/ Location	Tube	Pan	Percentage of Total Weight Retained on Each Screen						Wt(g)
			Screen 38	Size 63	in 125	Microns 250	500	1000	
June West 500m	A	18.87	19.81	22.64	19.81	16.98	1.89	0.00	0.106
	B	18.92	20.27	20.27	18.92	17.57	4.05	0.00	0.074
July East 50m	A	12.20	25.90	30.50	21.50	7.73	1.99	0.00	3.064
	B	13.00	25.40	29.80	21.10	8.36	2.12	0.00	2.690
July East 100m	A	9.98	28.00	31.60	16.50	9.42	4.34	0.00	2.695
	B	14.60	22.90	31.40	16.60	11.60	2.68	0.00	0.559
July East 150m	A	13.90	26.20	24.00	19.50	12.20	3.91	0.00	0.179
	B	8.44	21.70	31.60	19.20	9.79	9.09	0.00	2.156
	C	12.00	24.50	32.30	19.30	8.94	2.66	0.00	2.482
July East 200m	A	8.63	20.40	24.80	17.90	17.90	10.10	0.00	2.619
	B	9.36	23.60	27.80	17.20	19.60	2.20	0.00	3.089
July East 250m	A	8.14	17.30	25.30	19.30	18.50	11.30	0.00	2.112
	B	9.92	21.30	27.50	15.00	14.60	11.50	0.00	2.247
July East 300m	A	6.37	19.90	25.60	24.10	18.30	5.59	0.00	1.790
	B	9.63	19.80	26.40	21.70	18.80	3.54	0.00	1.640
July East 400m	A	11.80	26.30	29.20	17.30	16.20	0.00	0.00	1.232
	B	10.10	20.00	26.80	18.90	18.30	5.63	0.00	1.083
July East 500m	A	3.88	13.40	18.30	15.40	37.40	8.06	3.48	1.005
	B	8.00	16.00	20.00	17.10	22.90	1.19	14.70	1.262
July West 50m	A	14.90	22.80	28.30	18.60	10.90	4.30	0.00	1.162
	B	16.20	24.30	31.30	21.40	5.43	1.19	0.00	1.345
July West 100m	A	18.80	23.50	32.90	14.30	7.55	2.78	0.00	1.549
	B	23.90	21.90	32.50	13.20	4.42	3.96	0.00	1.743
July West 150m	A	21.20	27.00	32.40	14.90	3.77	0.54	0.00	1.114
	B	13.90	25.20	31.90	14.40	13.00	1.36	0.00	1.246
July West 200m	A	25.00	24.00	28.20	13.50	8.53	0.52	0.00	2.320
	B	21.40	28.00	25.40	17.40	6.86	0.73	0.00	2.477
July West 250 m	A	13.90	24.20	26.70	18.20	14.60	2.11	0.00	1.801
	B	14.90	27.30	32.00	18.40	6.51	0.82	0.00	1.950

APPENDIX 9 CONTINUED
PARTICLE SIZE DISTRIBUTION
FOR INTAKE SEDIMENT SAMPLES - 1985

Month/ Location	Tube	Pan	Percentage of Total Weight Retained on Each Screen						Wt(g)
			Screen 38	Size 63	in 125	Microns 250	500	1000	
July West 300m	A	18.20	30.50	28.20	14.20	8.43	0.23	0.00	0.854
	B	23.60	29.30	28.60	11.60	5.82	0.82	0.00	0.980
July West 400m	A	13.90	25.80	23.90	17.60	12.70	5.80	0.00	1.361
	B	17.90	27.40	24.60	17.30	10.80	1.80	0.00	1.275
July West 500m	A	15.80	18.50	18.90	20.80	19.70	6.06	0.00	1.517
	B	23.90	18.80	22.60	21.90	11.40	1.12	0.00	1.334
August East 50m	A	8.23	15.00	25.50	23.00	22.70	3.43	1.89	1.750
	B	4.45	5.45	44.20	18.30	17.50	6.07	3.92	2.092
August East 100m	A	7.05	14.70	21.00	23.60	28.70	4.73	0.00	1.460
	B	7.85	12.10	23.40	24.10	27.00	5.25	0.00	1.733
August East 150m	A	3.93	9.32	13.90	7.95	43.00	6.30	15.50	1.095
	B	8.69	8.18	11.10	15.30	41.20	9.21	6.20	1.162
August East 200m	A	11.10	12.80	13.80	19.30	39.20	2.87	0.64	1.396
	B	7.74	10.80	13.60	20.20	44.80	1.68	1.02	1.370
August East 250m	A	9.91	11.70	12.60	17.30	44.50	3.03	0.87	1.847
	B	6.23	10.10	10.90	16.10	35.40	17.70	3.25	1.879
August East 300m	A	4.38	9.75	11.40	15.90	41.80	10.60	5.96	1.528
	B	6.54	10.10	11.20	18.80	48.50	3.94	0.67	1.346
August East 400m	A	6.73	9.41	12.10	18.60	38.80	7.74	6.44	1.382
	B	-	-	-	-	-	-	-	-
August East 500m	A	5.58	12.00	12.20	20.60	41.20	6.26	2.09	1.917
	B	13.20	15.70	16.00	19.30	30.50	4.69	0.39	1.811
August West 50m	A	5.36	15.40	30.70	16.60	23.30	8.45	0.00	1.810
	B	4.32	11.30	24.3	23.8	21.5	14.6	0.00	3.538
August West 100m	A	7.42	16.50	33.10	23.40	17.40	1.93	0.00	0.984
	B	5.23	13.40	20.70	19.10	29.50	11.90	0.00	1.244
August West 150m	A	5.92	17.40	25.70	20.70	27.70	2.42	0.00	1.115
	B	5.84	16.40	22.60	21.80	25.60	7.49	0.00	1.028
August West 200m	A	9.13	16.30	17.20	21.50	30.00	3.61	2.01	0.997
	B	6.06	14.80	16.70	15.70	36.10	8.49	1.87	0.907

APPENDIX 9 CONTINUED
PARTICLE SIZE DISTRIBUTION
FOR INTAKE SEDIMENT SAMPLES - 1985

Month/ Location	Tube	Pan	Percentage of Total Weight Retained on Each Screen						Wt(g)
			Screen 38	Size 63	in 125	250	500	1000	
August West 250m	A	8.64	11.90	16.00	19.20	28.40	15.60	0.00	0.660
	B	-	-	-	-	-	-	-	-
August West 300m	A	6.50	13.50	16.90	20.40	27.60	14.90	0.00	0.815
	B	6.03	9.62	15.00	15.50	33.70	20.10	0.00	0.780
August West 400m	A	11.80	15.30	25.60	22.50	18.10	6.52	0.00	0.644
	B	8.18	18.20	24.00	20.30	18.60	10.40	0.00	0.953
August West 500m	A	12.30	14.40	31.30	23.80	14.70	3.17	0.00	0.663
	B	8.74	18.50	30.60	23.50	13.10	5.33	0.00	0.675
September East 50m	A	12.50	15.30	23.10	21.70	18.60	8.49	0.00	4.028
	B	9.17	14.80	21.90	22.30	23.60	8.09	0.00	3.970
September East 100m	A	7.49	9.98	15.10	16.60	21.00	29.70	0.00	3.297
	B	13.40	17.00	23.00	21.90	20.80	3.65	0.00	3.425
September East 150m	A	16.60	21.30	24.10	19.00	17.20	1.60	0.00	2.556
	B	10.10	15.20	20.70	22.80	25.20	5.73	0.00	2.862
September East 200m	A	9.56	11.00	13.70	13.60	16.10	35.80	0.00	3.232
	B	8.46	12.80	17.40	18.00	22.40	20.70	0.00	3.216
September East 250m	A	23.80	18.70	23.60	20.00	12.10	1.60	0.00	2.685
	B	9.77	17.10	22.80	23.50	19.90	6.38	0.00	2.488
September East 300m	A	9.06	13.50	17.40	19.30	26.40	1.98	12.20	2.626
	B	15.7	15.5	16.0	16.8	30.3	4.75	0.72	2.230
September East 400m	A	12.20	10.60	18.00	20.90	31.30	6.78	0.00	2.566
	B	9.48	12.00	18.00	22.60	35.80	1.96	0.00	2.404
September East 500m	A	9.42	15.20	17.10	19.90	30.40	7.77	0.00	2.727
	B	7.43	11.60	16.80	21.50	31.80	10.70	0.00	2.828
September West 50m	A	11.60	10.70	10.50	13.50	21.80	31.60	0.00	5.083
	B	10.60	9.72	10.30	15.10	25.10	28.90	0.00	4.765
September West 100m	A	12.50	10.40	13.10	18.50	28.20	17.10	0.00	2.524
	B	12.20	11.90	13.10	20.30	28.70	13.50	0.00	2.532
September West 150m	A	12.90	11.80	15.10	20.00	31.10	8.91	0.00	2.144
	B	18.40	14.90	10.90	16.80	27.00	11.70	0.00	2.677

APPENDIX 9 CONTINUED
PARTICLE SIZE DISTRIBUTION
FOR INTAKE SEDIMENT SAMPLES - 1985

Month/ Location	Tube	Percentage of Total Weight Retained on Each Screen							Wt(g)
		Pan	Screen 38	Screen 63	Screen 125	Screen 250	Screen 500	Screen 1000	
September West 200m	A	6.34	6.89	13.70	25.00	44.80	3.17	0.00	0.915
	B	5.65	10.00	14.40	22.30	34.10	13.40	0.00	0.955
September West 250m	A	7.68	7.25	10.00	14.10	29.20	31.60	0.00	2.814
	B	15.00	14.90	18.20	23.90	25.70	2.05	0.00	2.632
September West 300m	A	14.40	12.90	15.20	22.10	28.60	6.64	0.00	1.914
	B	15.80	15.00	20.10	21.70	23.80	3.28	0.00	2.196
September West 400m	A	16.40	15.60	19.60	20.30	24.60	3.20	0.00	1.874
	B	18.90	20.80	21.40	21.90	16.00	0.79	0.00	1.905
September West 500m	A	8.10	10.90	15.40	24.70	33.60	7.12	0.00	2.246
	B	11.90	12.20	16.50	22.70	28.40	8.04	0.00	2.536
November West 50m	A	3.80	14.70	23.60	16.60	32.30	6.45	2.32	44.790
	B	5.77	12.70	18.50	11.40	38.10	8.09	5.24	44.870
November West 100m	A	6.12	11.30	21.10	10.30	45.30	4.00	1.61	63.230
	B	5.81	12.90	18.90	14.00	43.90	2.75	1.64	65.370
November West 150m	A	7.29	16.40	19.30	9.17	39.10	4.73	3.94	35.550
	B	8.26	14.60	21.90	10.80	38.60	4.07	1.61	34.640
November West 200m	A	9.60	20.00	28.60	16.50	23.00	0.79	1.38	40.520
	B	10.10	14.10	26.90	12.60	33.00	1.71	1.48	42.710
November West 250m	A	9.90	13.80	23.60	15.40	31.40	3.89	1.82	52.120
	B	7.20	12.90	22.40	8.25	42.80	3.10	3.27	43.170
November West 300m	A	9.41	15.80	25.90	26.80	19.30	1.43	1.26	42.070
	B	8.32	17.10	27.10	10.41	32.50	2.31	2.16	47.580
November West 400m	A	3.41	7.81	13.10	11.80	13.90	5.22	44.50	91.070
	B	6.07	12.10	26.50	21.10	27.00	5.13	1.94	46.630
November West 500m	A	7.38	15.20	21.40	14.90	33.80	4.28	2.86	57.020
	B	8.22	15.90	31.10	12.20	27.20	2.06	3.26	48.530

APPENDIX 9 CONTINUED
 PARTICLE SIZE DISTRIBUTION
 FOR INTAKE SEDIMENT SAMPLES - 1985

Month/ Location	Tube	Pan	Percentage of Total Weight Retained on Each Screen						Wt(g)
			Screen 38	Size 63	in 125	Microns 250	500	1000	
March 86	A	4.80	13.50	18.30	18.20	36.00	8.84	0.23	641.700
East 50m	B	7.46	12.00	16.70	19.00	40.30	3.78	0.63	698.700
March 86	A	3.21	8.68	16.80	21.30	41.40	5.40	3.06	46.090
East 100m	B	3.44	9.00	15.50	14.10	47.10	8.55	2.18	51.790
March 86	A	5.08	12.90	18.90	17.30	23.30	9.47	12.90	40.750
East 150m									
March 86	A	3.82	14.70	24.60	13.80	34.00	8.01	0.95	31.450
East 500m									

APPENDIX 10

PARTICLE SIZE DISTRIBUTION
FOR DUMPSITE SEDIMENT SAMPLES - 1985

APPENDIX 10
PARTICLE SIZE DISTRIBUTION
FOR DUMPSITE SEDIMENT SAMPLES - 1985

Month/ Location	Tube	Percentage of Total Weight Retained on Each Screen							Wt(g)
		Pan	Screen 38	Screen 63	Screen 125	Screen 250	Screen 500	Screen 1000	
June Centre	A	9.07	19.11	20.80	21.77	27.57	1.09	0.60	0.827
	B	6.30	13.35	21.15	25.38	30.36	2.63	0.85	1.064
June East 200m	A	11.62	21.21	27.27	28.28	9.60	2.02	0.00	0.198
	B	20.05	25.99	19.80	16.58	12.62	1.73	3.22	0.404
June East 400m	A	16.16	24.24	13.64	26.77	5.05	14.14	0.00	0.198
	B	11.02	22.46	21.19	23.73	19.07	1.69	0.85	0.236
June East 600m	A	14.88	4.13	52.07	20.66	6.61	1.65	0.00	0.121
	B	19.13	22.61	26.96	12.17	13.04	2.61	3.48	0.115
June East 800m	A	10.28	11.84	22.74	28.97	21.18	4.98	0.00	0.321
	B	15.05	20.43	25.27	15.05	11.29	12.90	0.00	0.186
June East 1000m	A	13.24	23.53	26.47	16.18	10.29	5.88	4.41	0.068
	B	5.88	30.88	32.35	19.12	4.41	4.41	2.94	0.068
June East 1200m	A	14.71	38.24	5.88	4.41	23.53	4.41	8.82	0.068
	B	30.00	22.86	18.57	11.43	7.14	4.29	5.71	0.070
June East 1400m	A	6.67	18.33	24.17	20.83	9.17	4.17	16.67	0.120
	B	18.82	24.71	21.18	4.71	11.76	14.12	4.71	0.085
June West 200m	A	5.59	10.74	18.12	31.84	26.49	7.22	0.00	2.952
	B	5.57	14.02	24.14	22.98	27.88	5.41	0.00	1.976
June West 400m	A	8.41	12.68	24.78	33.62	18.55	1.96	0.00	1.380
	B	9.74	16.10	27.45	29.22	16.41	1.07	0.00	1.304
June West 600m	A	8.87	18.39	27.10	24.03	19.84	1.77	0.00	0.620
	B	11.57	22.93	36.16	19.42	9.09	0.83	0.00	0.484
June West 800m	A	15.07	23.97	34.25	15.07	9.59	2.05	0.00	0.146
	B	15.53	21.21	23.48	15.15	12.88	11.74	0.00	0.264
June West 1000m	A	11.29	17.74	23.39	22.58	19.35	5.65	0.00	0.124
	B	7.19	11.76	29.41	26.14	19.61	5.88	0.00	0.153
June West 1200m	A	7.48	14.96	22.05	23.23	9.45	22.83	0.00	0.254
	B	7.92	16.34	32.18	22.77	18.81	1.98	0.00	0.202
June West 1400m	A	25.69	12.84	19.27	15.60	14.68	11.93	0.00	0.109
	B	19.83	25.62	23.14	21.49	7.44	2.48	0.00	0.121

APPENDIX 10 CONTINUED
PARTICLE SIZE DISTRIBUTION
FOR DUMPSITE SEDIMENT SAMPLES - 1985

Percentage of Total Weight Retained on Each Screen									
Month/ Location	Tube	Pan	Screen Size in Microns						Wt(g)
			38	63	125	250	500	1000	
June West 1600m	A	11.02	18.90	23.62	20.47	22.83	3.15	0.00	0.127
	B	19.30	25.50	21.40	18.80	10.20	4.59	0.00	0.196
July Centre	A	5.07	6.78	12.10	35.80	38.20	1.91	0.00	1.520
	B	4.53	9.27	13.20	33.30	38.00	1.56	0.00	1.921
July East 200m	A	3.40	30.10	20.70	28.30	5.66	11.70	0.00	0.265
	B	-	-	-	-	-	-	-	-
July East 400m	A	14.70	18.00	26.40	19.70	15.10	5.88	0.00	0.238
	B	12.70	24.50	29.00	15.90	13.60	4.09	0.00	0.220
July East 600m	A	12.40	19.60	17.10	14.00	32.80	3.87	0.00	0.362
	B	1.02	1.78	1.67	4.96	78.40	11.60	0.51	4.500
July East 800m	A	9.63	20.30	20.80	19.20	19.20	10.70	0.00	0.187
	B	6.58	13.30	10.40	9.34	54.90	5.31	0.00	0.471
July East 1000m	A	7.32	13.50	15.40	17.80	41.70	4.07	0.00	0.369
	B	9.71	16.00	22.80	18.90	29.60	2.91	0.00	0.206
July East 1200m	A	13.60	21.40	23.30	17.50	15.50	8.56	0.00	0.257
	B	-	-	-	-	-	-	-	-
July East 1400m	A	1.80	3.06	2.85	5.49	47.50	39.20	0.00	0.947
	B	1.54	2.91	3.42	9.84	66.90	15.30	0.00	1.169
July West 200m	A	no sample							
	B	no sample							
July West 400m	A	12.00	20.00	30.00	24.30	11.50	1.89	0.00	0.423
	B	14.20	26.80	30.40	21.90	6.03	0.55	0.00	0.365
July West 600m	A	10.60	22.80	25.90	22.00	17.70	0.80	0.00	0.377
	B	11.00	30.70	30.00	18.20	8.21	1.79	0.00	0.280
July West 800m	A	9.58	24.50	32.50	24.50	7.92	0.83	0.00	0.240
	B	9.82	25.00	24.70	22.90	15.20	2.18	0.00	0.275
July West 1000m	A	6.96	18.20	27.30	24.30	22.10	0.87	0.00	0.230
	B	6.35	15.30	20.60	24.30	31.70	1.59	0.00	0.189
July West 1200m	A	8.57	17.50	26.90	22.40	22.80	1.63	0.00	0.245
	B	6.05	18.60	26.90	26.50	18.60	3.26	0.00	0.215

APPENDIX 10 CONTINUED
PARTICLE SIZE DISTRIBUTION
FOR DUMPSITE SEDIMENT SAMPLES - 1985

Month/ Location	Tube	Percentage of Total Weight Retained on Each Screen							Wt(g)
		Pan	Screen 38	Size 63	in 125	Microns 250	500	1000	
July	A	no sample							
West 1400m	B	no sample							
July	A	12.00	21.30	29.30	26.00	10.00	1.33	0.00	0.150
West 1600m	B	10.10	29.10	31.00	22.70	5.70	1.27	0.00	0.158
August	A	12.90	14.10	26.50	24.30	20.20	1.85	0.00	0.864
Centre	B	11.50	14.50	25.20	22.00	23.30	3.25	0.00	1.138
August	A	0.77	2.53	5.44	15.80	35.50	5.43	34.40	7.759
East 200m	B	4.70	4.34	7.48	17.80	21.50	6.60	37.50	13.510
August	A	3.89	10.00	13.50	36.90	32.40	3.18	0.00	0.848
East 400m	B	5.34	11.30	25.50	30.60	22.00	5.09	0.00	1.237
August	A	7.01	14.50	22.70	24.90	24.10	6.67	0.00	0.585
East 600m	B	8.78	15.30	21.20	28.30	22.60	3.55	0.00	0.592
August	A	4.71	6.47	11.10	17.40	50.50	7.06	2.55	0.510
East 800m	B	3.38	8.56	15.50	20.90	43.00	7.43	1.13	0.444
August	A	3.85	6.22	9.93	18.90	34.50	26.50	0.00	0.675
East 1000m	B	4.17	6.76	12.30	19.70	29.70	27.10	0.00	0.695
August	A	9.09	12.50	16.00	25.50	25.80	10.80	0.00	0.286
East 1200m	B	9.58	9.58	16.70	20.60	39.80	3.59	0.00	0.334
August	A	6.43	11.20	14.40	18.00	47.30	1.61	0.80	0.249
East 1400m	B	7.59	9.28	14.70	21.10	40.50	6.75	0.00	0.237
August	A	3.60	8.38	15.30	15.90	28.60	27.30	0.76	3.282
West 200m	B	7.22	11.10	22.70	40.10	8.92	9.24	0.66	4.113
August	A	6.13	12.60	15.70	23.70	40.60	1.15	0.00	0.261
West 400m	B	8.76	10.90	11.60	24.00	41.20	3.28	0.00	0.274
August	A	11.20	8.88	25.70	21.80	24.80	4.73	2.66	0.338
West 600m	B	7.47	9.96	27.30	29.40	23.00	1.04	1.66	0.482
August	A	1.67	1.94	3.34	13.50	60.40	9.49	9.63	1.496
West 800m	B	0.35	0.83	1.83	8.44	86.00	2.03	0.51	8.638
August	A	8.12	14.90	21.20	26.90	25.30	3.42	0.00	0.702
West 1000m	B	13.40	16.40	23.70	28.90	16.40	0.97	0.00	0.619

APPENDIX 10 CONTINUED
PARTICLE SIZE DISTRIBUTION
FOR DUMPSITE SEDIMENT SAMPLES - 1985

Month/ Location	Tube	Percentage of Total Weight Retained on Each Screen							Wt(g)
		Pan	Screen 38	Size 63	in Microns		500	1000	
August West 1200m	A	9.98	11.80	16.00	25.70	23.90	12.50	0.00	0.431
	B	9.72	14.80	19.60	23.80	26.80	5.09	0.00	0.432
August West 1400m	A	7.27	11.50	16.40	20.20	30.30	2.66	11.50	0.564
	B	8.25	15.30	25.70	22.80	23.80	4.01	0.00	0.424
August West 1600m	A	4.21	10.00	14.20	27.30	42.30	1.84	0.00	0.380
	B	5.74	10.20	13.90	23.20	26.80	19.90	0.00	0.331
September East 200m	A	5.79	10.00	16.00	21.30	41.40	5.38	0.00	2.192
	B	5.13	11.90	19.90	28.10	32.70	2.06	0.00	2.084
September East 1200m	A	10.20	9.81	12.40	19.10	36.00	12.20	0.00	0.846
	B	7.15	8.81	12.20	19.00	40.10	12.60	0.00	1.147
November Centre	A	2.61	4.26	10.70	31.70	48.30	1.67	0.71	17.920
	B	1.45	3.57	9.22	35.00	45.70	2.49	2.56	17.350
November East 1000m	A	2.83	3.72	7.20	24.30	58.00	2.97	0.89	9.419
	B	no sample							
December East 200m	A	0.39	0.54	0.81	10.40	76.90	10.60	0.14	140.300
	B	0.41	0.59	0.99	13.00	73.80	11.00	0.07	133.200
December East 400m	A	2.27	3.73	11.50	44.20	33.30	3.80	1.03	7.343
	B	1.59	3.41	10.40	40.10	36.90	4.55	2.95	7.854
December East 600m	A	2.05	5.20	12.10	30.90	45.20	3.22	1.24	5.502
	B	5.65	9.84	19.10	25.70	34.70	2.73	2.16	1.575
December East 800m	A	0.33	0.51	1.40	9.96	69.90	16.80	1.03	96.000
	B	2.77	4.07	9.40	25.10	51.40	6.16	0.99	5.731
December East 1000m	A	2.19	2.05	4.86	22.80	64.80	2.27	0.93	18.970
	B	1.37	1.92	4.65	26.20	62.90	2.63	0.38	17.330
December East 1200m	A	1.48	2.67	7.06	32.50	50.40	3.59	2.16	10.160
	B	0.36	0.66	1.08	10.80	64.80	20.50	1.65	73.380
December East 1400m	A	2.66	4.33	11.30	26.60	50.20	3.46	1.25	7.021
	B	2.38	4.35	11.90	34.80	41.60	2.70	2.05	7.174
December West 200m	A	2.89	7.10	18.10	30.40	35.10	4.41	1.85	7.117
	B	3.68	5.95	16.10	31.10	31.70	5.59	5.93	11.480

APPENDIX 10 CONTINUED
PARTICLE SIZE DISTRIBUTION
FOR DUMPSITE SEDIMENT SAMPLES - 1985

Month/ Location	Tube	Percentage of Total Weight Retained on Each Screen							Wt(g)
		Pan	Screen 38	Size 63	in 125	Microns 250	500	1000	
December	A	3.77	5.11	12.40	27.40	46.00	5.09	0.00	9.893
West 400m	B	4.09	2.01	5.40	11.70	57.40	3.62	15.60	92.720
December	A	1.15	2.33	4.43	16.16	68.60	1.29	5.50	30.720
West 800m	B	4.52	5.20	8.53	22.90	55.20	1.80	1.83	12.310
December	A	0.82	0.96	2.01	8.02	76.60	10.50	1.07	58.090
West 1400m	B	0.89	1.40	2.72	10.50	80.20	3.07	1.12	45.250

APPENDIX 11

ANALYSIS OF GILL NET FISH CATCH DATA

- DARLINGTON 1985 ALEWIFE
- DARLINGTON 1984 & 1985 ROUND WHITEFISH
- DARLINGTON 1985 LAKE TROUT
- DARLINGTON 1985 BROWN TROUT

APPENDIX 11A
ANALYSIS OF GILL NET FISH CATCH DATA
DARLINGTON 1985 ALEWIFE (Log n+1)
LOCATION x DEPTH (surface & bottom)

ANALYSIS OF VARIANCE (random block design)

SOURCE	SUM SQUARES	df	MEAN SQUARE	F-RATIO
session	51.70154	7		
location	2.174331	3	0.724777	4.340514 **
depth	0.2247915	1	0.2247915	1.346222 NS
loc x depth	0.2594154	3	8.647182E-2	0.517858 NS
error	8.181997	49	0.1669795	
total	62.54207	63		

DUNCAN'S NEW MULTIPLE RANGE TEST:

- Results indicate that catch at location D is significantly lower than at locations H,A,F. There are no significant differences between sites H,A, and F.

APPENDIX 11B
ANALYSIS OF GILL NET FISH CATCH DATA
DARLINGTON 1985 ROUND WHITEFISH (Log n+1)
LOCATION x DEPTH (surface & bottom)

ANALYSIS OF VARIANCE (random block design)

SOURCE	SUM SQUARES	df	MEAN SQUARE	F-RATIO
session	4.490813	7		
location	0.3454726	3	0.1151575	1.200052 NS
depth	2.065945	1	2.065945	21.52913 **
loc x depth	0.194497	3	6.48323E-2	0.675615 NS
error	4.702062	49	9.59604E-2	
total	11.79879	63		

APPENDIX 11C
ANALYSIS OF GILL NET FISH CATCH DATA
DARLINGTON 1984 & 1985 ROUND WHITEFISH (Log n+1)
LOCATION x YEARS (July-December data)

ANALYSIS OF VARIANCE (random block design)

SOURCE	SUM SQUARES	df	MEAN SQUARE	F-RATIO
session	6.775365	5		
location	0.4840306	3	0.1613435	1.424722 NS
year	0.1420345	1	0.1420345	1.254216 NS
loc x year	0.42628	3	0.1420933	1.254736 NS
error	3.963597	35	0.1132456	
total	11.79131	47		

APPENDIX 11D
ANALYSIS OF GILL NET FISH CATCH DATA
DARLINGTON 1984 & 1985 ROUND WHITEFISH (Log n+1)
LOCATION x YEARS (October-December data)

ANALYSIS OF VARIANCE (random block design)

SOURCE	SUM SQUARES	df	MEAN SQUARE	F-RATIO
session	3.056155	3		
location	1.202823	3	0.4009411	3.254521 *
year	0.2650092	1	0.2650092	2.151134 NS
loc x year	0.5192499	3	0.1730833	1.404953 NS
error	2.587097	21	0.1231951	
total	7.630335	31		

DUNCAN'S NEW MULTIPLE RANGE TEST:

Locations	H	D	F	A
log means	0.419	0.560	0.767	0.928

- catch at site A is significantly larger than at site H.
- catches at sites D & F are not significantly different than extreme low or high values.

APPENDIX 11E
ANALYSIS OF GILL NET FISH CATCH DATA
DARLINGTON 1985 LAKE TROUT (Log n+1)
LOCATION x DEPTH (surface & bottom nets)

ANALYSIS OF VARIANCE (random block design)

SOURCE	SUM SQUARES	df	MEAN SQUARE	F-RATIO
session	3.11316	7		
location	1.56734E-2	3	5.2245E-3	9.915E-2 NS
depth	0.3366913	1	0.3366913	6.389949 *
loc x depth	0.2175489	3	7.2516E-2	1.376262 NS
error	2.581847	49	5.2691E-2	
total	6.26492	63		

APPENDIX 11F
ANALYSIS OF GILL NET FISH CATCH DATA
DARLINGTON 1985 BROWN TROUT (Log n+1)
LOCATION x DEPTH (surface & bottom nets)

ANALYSIS OF VARIANCE (random block design)

SOURCE	SUM SQUARES	df	MEAN SQUARE	F-RATIO
session	0.957722	7		
location	9.1938E-2	3	3.0646E-2	0.854824 NS
depth	0.1677375	1	0.1677375	4.678766 *
loc x depth	0.1542836	3	5.1428E-2	1.434497 NS
error	1.75669	49	3.5851E-2	
total	3.128371	63		